7.3 DOCUMENT CHANGE CONTROL

1.0 GENERAL REQUIREMENTS

1.1 BASIS AND SCOPE OF THE REQUIREMENTS

This Performance Assurance Requirements (PAR) document is an adaptation of the applicable requirements of the National Aeronautics and Space Administration (NASA) Reliability and Quality Assurance Handbooks NHB 5300.4 (1A and 1B), and the Standard Payload Assurance Requirements (SPAR) for Goddard Space Flight Center (GSFC) Orbital Projects. It establishes common hardware and software product assurance requirements in the areas of safety, reliability, maintainability, and quality for the design, development, acquisition, test and operation of the EOS Data and Information System (EOSDIS) Core System (ECS). These requirements are compatible with those of the Functional and Performance Requirements Specification for the EOSDIS Core System (ECS F&P Specification) and the ECS Statement of Work (see Appendix A).

These assurance requirements recognize the selected design approach of integrating existing commercial off-the-shelf (COTS) hardware into a system design that may include custom hardware designs. This hardware, when used with a combination of existing and custom developed software and some COTS software, is intended to provide the necessary functional availability and system safety to perform satisfactorily the ECS ground command and data handling functions for the EOS mission.

This PAR document covers: (a) the design, development, integration and test of the ECS, (b) the maintenance and operation of the ECS and the Platform Analysis System (PAS) and Platform Test and Training System (PTTS), and (c) ECS external interfaces, including the support of all systems level tests of the ECS with the EOSDIS and higher level systems testing.

The development approach chosen for EOSDIS is planned to be accomplished step-wise in a series of incremental developments, called "versions" which develop first an operating capability for the basic functions of EOSDIS, and then successively add and integrate the related supplemental capabilities for one additional set of functions after another until the full operational capability of EOSDIS is developed and validated. The scope of each of these versions (Version

0, 1, 2, and 3) and two "enhanced" updates is defined broadly in the SOW for the ECS contract. The corresponding increments of ECS development are called "releases". Releases 1 through 7 correspond to the ECS portion of the six whole and partial EOSDIS "versions". Release 2 is an extension from the Release 1 design; Release 3 is a similar development extended from Release 2, and so forth.

This PAR will treat each release cycle of ECS as a separate (but interrelated) development program (based on its portion of the overall ECS requirements), starting with the Preliminary Design Review for the release and ending with formal acceptance of the release after the Project's Release Readiness Review (RRR) for that release and its integration into the operational ECS.

1.2 PERFORMANCE ASSURANCE PROGRAM

The contractor shall plan and implement an organized performance assurance program that encompasses system hardware (including spares) and software, government-furnished equipment, and to the extent defined herein, other support equipment and software. The performance assurance program shall assure that the above mentioned products meet all physical, functional and performance requirements of their procurement specifications and that the integrated system meets the functional and performance requirements of the mission, including required margins, and will operate properly with all other project elements. The program shall verify that all products conform with applicable procurement requirements and will perform satisfactorily in meeting EOSDIS mission and data system requirements. This will be accomplished by conducting analyses, reviews, tests, inspections, and audits.

The performance assurance program applies to all work accomplished under the ECS contract by its contractor, subcontractors, and suppliers and to maintenance and operations activities of the ECS under extensions of, or successors to the ECS contract. The term "contractor" as used herein means the ECS contractor, subcontractors, and suppliers for all activities under the ECS contract. Performance assurance requirements for the IV&V contract are referenced in the "PAR for the IV&V of the EOSDIS".

1.3 PERFORMANCE ASSURANCE IMPLEMENTATION PLAN (PAIP)

The ECS contractor shall prepare a Performance Assurance Implementation Plan (PAIP) which shall describe the

contractor's plan for accomplishing the assurance activities in compliance with the requirements herein. The contractor shall submit the PAIP in accordance with the Contract Data Requirements List (CDRL) (see Appendix C herein). The PAIP shall include a separate plan for each Distributed Active Archive Center (DAAC) (called a DAAC PAIP) to describe clearly the planned implementation of the PAR at each DAAC.

The approved PAIP and this document shall become part of the contract negotiated between the contractor and the Goddard Space Flight Center. If any inconsistencies between the approved PAIP and this document become evident, this document shall take precedence, except where a Deviation has been formally identified by the ECS contractor and approved by the Contracting Officer (see DID 527/PA1).

The contractor is encouraged to make maximum use of his existing practices and procedures in complying with this document. The applicable documents shall be submitted in accordance with par. 1.3.2, below.

1.3.1 PREPARATION OF THE PAIP

The PAIP shall address each of the seven sections of this document and shall describe specifically and in detail how the requirements are to be accomplished; in addition, the Plan shall include:

a. Organization chart and defined responsibilities.

b. Matrix of the requirements, referencing the applicable paragraph numbers in the Plan versus the implementation procedures, instructions and specifications and indicating the organizations responsible for implementing and auditing each requirement.

c. A list of assurance services that may be procured, identifying the proposed subcontractor.

d. Identification of significant hardware and software items to be purchased and a detailed description of the manner and degree to which the portions of this document are to be imposed on each item (see par. 1.4).

1.3.2 IMPLEMENTING PROCEDURES

The contractor shall provide one copy of each procedure and documented instruction referenced in the plan. These documents and any subsequent revision to any of them shall be submitted in accordance with the CDRL (see Appendix C herein).

1.4 USE OF PREVIOUSLY DESIGNED HARDWARE AND SOFTWARE

The contractor shall ensure that the previously developed CH09

hardware, and the previously developed software (other than software developed for an earlier release of the ECS) meet the ECS requirements as follows:

a. Hardware. The contractor shall ensure that all hardware units used have the reliability, maintainability, and availability (RMA) data required to support the design and evaluation of a ground system meeting the system requirements as well as the specific requirements stated in the ECS F&P Specification (referenced in Appendix A herein). The specifications for previously developed hardware shall include RMA, interface, and quality requirements. The contractor shall also ensure that the delivered hardware meets the specified requirements. CH09

b. Previously Developed Software. For all previously developed software proposed for use for the ECS, the contractor shall: CH09

(1) Compare the software requirements statement for the existing software item with the requirements for the item's function on EOSDIS and ensure that each design and interface requirement for the existing item will meet the corresponding EOSDIS requirement without introduction of extraneous features which can potentially interfere with the functions on EOSDIS.

(2) The contractor shall review all verification and validation (V&V) records for the previously developed program and document each requirement, characteristic, and function verification from the previous use and the directness of its applicability for the corresponding ECS requirement. For any parts of the previous V&V program that are not identical with the corresponding V&V requirements for ECS, the contractor shall document the differences and justify the acceptability of the previous V&V for EOS or describe what additional measures are planned to demonstrate the suitability of the software item for ECS.

(3) Identify all waivers and deviations accepted on

the previous program which potentially involve this software. If any of these waivers or deviations affect a software design requirement of the previous program that is also a requirement of the ECS, describe what will be done to achieve compliance or provide a rationale and supporting information stating why the difference is considered acceptable.

(4) Describe all mission experience with the previously developed software including, in particular, a description of all problems or anomalies potentially involving this software, their cause, and any corrective action that was taken as a result.

(5) Describe the additional testing planned to demonstrate the compatibility of the previously developed software with the other ECS software and hardware, and identify the measures to be taken to ensure that the previously developed item does not introduce unwanted effects potentially resulting in malfunctions in system operation.

c. (Deleted) CH09

The documentation described above shall be submitted to NASA in accordance with the CDRL (see Appendix C herein).

1.5 MANAGEMENT OF THE ASSURANCE PROGRAM

The contractor shall establish a system for effective management control, implementation, and audit of the assurance program and shall assign responsibility and authority for managing the assurance activities to individuals having access to contractor management that is independent of contractor project management.

1.6 PERFORMANCE ASSURANCE STATUS REPORT

The contractor shall submit Performance Assurance Status Reports in accordance with the CDRL (see Appendix C herein). The reports shall include pertinent information and the status of items such as those listed below as well as those discussed in the individual sections of this PAR:

a. Key organization and personnel changes;

b. Significant assurance problems;

c. Safety issues;

d. Hardware inspection and test activities;

e. Software and system verification activities.

f. Procurements and subcontract assurance programs;

g. Audit report summaries of internal and subcontractor audits (see par. 1.9.2);

h. Summary reports of contractor reviews (see par. 2.5);

i. Alert (see Appendix B and par. 7.14) surveys;

j. Results of Trend Analyses;

k. Status summaries of open software nonconformance reports (see par6.6);

l. Status Summaries of open malfunction reports. (See par. 7.12.2.1b.);

m. Operating failures (by equipment, and failure frequency information);

n. Repair/replacement maintenance events;

o. Unavailability of required spares and attendant delays;

p. Significant operations or maintenance problems.

1.7 SURVEILLANCE OF THE CONTRACTOR

The work activities, operations, and documentation efforts performed under this contract by the contractor, subcontractors, or suppliers at all locations are subject to evaluation, review, survey, and inspection by Government designated representatives from the GSFC, the Government Inspection Agency (GIA), or independent assurance contractor (IAC). GSFC will delegate specific in-plant responsibilities and authority to those agencies in a letter of delegation or in the GSFC contract with the IAC.

The contractor, upon request, shall provide Government assurance representatives with documents, records, and equipment required to perform their assurance activities. The contractor shall also provide the Government assurance representatives a reasonable work area within the contractor's facilities.

Where contractor source inspection is used, the contractor shall provide a list of duties, responsibilities, and authorities of his at-source quality assurance (QA) personnel to the designated Government quality representative at the contractor's facility. When both contractor and Government source inspection personnel are used at any contractor's facility, the listing shall also be provided to the Government source representative at that facility, upon issuance of the procurement. At no time shall Government source inspection be used in lieu of contractor's source inspection.

1.8 PROCUREMENT REQUIREMENTS

1.8.1 SELECTION OF SOURCES

When the contractor selects procurement sources, he shall assign assurance personnel to participate in the selection. Performance history, receiving inspection and test results, supplier rating system, and survey results shall be used to assess the capability of each potential procurement source in producing reliable products.

1.8.2 REQUIREMENTS ON SUBCONTRACTOR AND SUPPLIERS

The contractor shall ensure that his procurement documents impose the applicable requirements of this document on subcontractors and other suppliers. The subcontractor and other suppliers shall in turn impose the requirements on

their procurement sources.

1.9 AUDITS AND REPORTS

The contractor shall plan and conduct an audit program consisting of audits of effectiveness of its internal performance assurance system and those of its subcontractors and suppliers to ensure compliance with the provisions of the PAIP and the contract. To verify the effectiveness of the performance assurance systems, each audit shall include examination of documentation (e.g., process specifications, procedures, analyses, reports), hardware and software, operations, and product. The audit program shall be defined in the PAIP and shall be submitted in accordance with the CDRL (see Appendix C herein).

1.9.1 SUBCONTRACTORS AND SUPPLIER AUDITS

The contractor shall perform audits of his subcontractors and suppliers as necessary to ensure compliance with the subcontractor performance assurance requirements. The contractor's schedule and conduct of the audits shall be based on the following:

a. Criticality of items being procured, as identified by function in the system, failure modes and effects analyses, information obtained from trend analyses, or other information;

b. Supplier history;

c. Known problems, such as Alerts; and,

d. Remaining period of contract performance.

The audit program for the subcontractors and suppliers shall be defined in the PAIP and shall be submitted in accordance with the CDRL (see Appendix C herein).

1.9.2 AUDIT REPORTS

A documented account of audits shall be provided to management of the audited organization with recommendations for correction of deficiencies. Management action shall be taken to ensure correction of the deficiencies, and reviews and re-audits shall be conducted to ensure that the corrections have been made. The audit reports shall be

available for information at the contractor's facility in accordance with the CDRL (see Appendix C herein). A summary of each audit report shall be submitted as part of the Performance Assurance Status Report (see par. 1.6).

1.10 APPLICABLE DOCUMENTS

To the extent referenced herein, applicable portions of the documents listed in Appendix A at the revision levels in effect at the time of issuance of the Request for Proposals, form a part of this document. Where any referenced document conflicts with the requirements of this document, contractors shall obtain guidance from the EOS Flight Assurance Manager.

1.11 ABBREVIATIONS, ACRONYMS, AND GLOSSARY

Appendix B lists the abbreviations, acronyms, and glossary of terms as applied in this document.

1.12 PERFORMANCE ASSURANCE DATA ITEMS FROM CONTRACT DATA REQUIREMENTS LIST

Deliverable data are specified in the Contract Data Requirements List (CDRL). Appendix C, provided here for reference, is a list of the CDRL items called for by this PAR document. Appendix C contains a list of the deliverable data, when the data shall be delivered and whether it is required for GSFC approval, review or information.

2.0 ASSURANCE REVIEW REQUIREMENTS

2.1 GENERAL REQUIREMENTS

The ECS contractor shall support a series of comprehensive assurance reviews of the ECS. The reviews shall cover all aspects of the system requirements, design, development, testing, and status and plans for hardware, software and operations. The contractor shall support three levels of external reviews and shall conduct an internal review program. The three levels of external reviews are: GSFC Assurance Team reviews, Project Team Reviews, and Project Document Only reviews. These reviews will be keyed to the ECS development life cycle. In addition to the above mentioned ECS reviews, the contractor shall also support a series of flight mission readiness reviews of the EOS flight missions as described in par. 2.6, below.

The principal ECS reviews are called out in the ECS contract Statement of Work (SOW). Further details of these and supplemental review requirements are stated in this section.

The EOSDIS and ECS are to be developed using a phased approach. The contractor shall first establish requirements and an overall architectural design for the entire ECS and then shall develop and install implementations of successive portions of the total requirements and design in a series of increments, called ECS releases. The development process for each ECS release shall be based on that portion of the original system requirements and overall architectural design pertinent to the current release and shall start the development cycle with a release level PDR and end in acceptance and installation into the ECS of the developed release. The incremental development of the EOSDIS (versions) and the corresponding development increments of the ECS (releases) will follow an orderly sequence of development steps: (a) review of the existing preliminary design and its extension (including any new requirements accepted for the forthcoming release), (b) detailed design, (c) coding of software and building/acquisition of hardware, (d) integration and verification of the hardware and software, (e) acceptance testing to validate the system design and performance, (f) acceptance by the Government of the ECS release, and (g) deployment of the new release and its integration into and acceptance at the various ECS sites and by the ECS users.

The assurance review program shall respond to these steps in the development cycle of each release with a corresponding series of reviews. At the completion of each development step of each release, the ECS contractor shall as a minimum submit to the GSFC project for approval the new and updated documents describing the results of the activities conducted during the completed release development step. The specific documents to be submitted are defined in the CDRL; these shall be written in accordance with the approved documentation standards adopted by the ECS contractor.

The least level of specific review shall be a Document Only review, with no presentation to a review team required of the contractor. In a Document Only review, the GSFC Project will review the documents, discuss them as needed with the Contractor, and, after dispositioning of any discrepancies, approve the results of the life cycle phase and approve the Contractor's beginning work on the next phase. At the discretion of the GSFC project, the contractor may be required to prepare charts and present the content of any Document Only review to an GSFC Project review team. (In such cases the contractor will be given a minimum of 15 working days' notice of the presentation requirement.)

Certain major life cycle reviews are designated as Project Team assurance reviews. For these the contractor shall support presentations to a review team appointed by the project as well as the document review defined above. These reviews are also specified in the ECS contract Statement of Work (SOW).

Further details of the assurance review requirements are stated in the paragraphs which follow.

2.2 GSFC REVIEW REQUIREMENTS

For each review the contractor shall:

a. Submit to the GSFC Project Office for review and approval the required documents developed and/or updated during the subject life cycle phase of the item being reviewed.

b. Support splinter review meetings resulting from the major review.

c. Produce written responses to recommendations and

action items resulting from the review in accordance with the CDRL (see Appendix C herein).

d. Close action items and discrepancies by making agreed upon changes in the reviewed material and the products defined and controlled by them.

e. For reviews involving a review team, the contractor shall, in addition to a. through d, develop, organize, and present material to the team. Copies of visual aids and other supporting material that are pertinent to the review shall be submitted in accordance with the CDRL (see Appendix C herein).

2.3 GSFC REVIEW PROGRAM

The reviews for each ECS release will be:

a. Preliminary Design Review (PDR) - PDRs shall be conducted at the segment level of the ECS by a GSFC Project Team; these will occur after completion of the preliminary design phase for each release. The PDRs for releases after Release 1, called intermediate design reviews (IDRs) in the SOW, will concentrate on the additional system capabilities provided by each new release. Each PDR will consider the planned implementations of the corresponding portions of the over-all system functions in a design of the new software and any associated additional or modified hardware. It will consider adequacy of allocation of the requirements to software components, the proposed architecture and preliminary design, and the preliminary plans for verification of the requirements by test. It will also consider the hardware planned for purchase, planned custom-designed hardware, and the predicted RMA for the ECS. The corresponding system level PDR, which will focus on segment interfaces, and element level PDRs for each release shall be Document Only reviews.

b. Critical Design Review (CDR) - The CDRs for each release will occur after the software and hardware designs have been finalized but prior to the writing of software code and the manufacture/ acquisition of the hardware (except for long-lead-time hardware, for which early manufacture/ acquisition may be approved by the Government). As with the PDRs, the CDRs for releases after Release 1 will concentrate on the additional system capabilities provided by each new release. The principal CDRs will occur at the element level and

be conducted by a Project Review Team. For software, the topics include the detailed design, its traceability to the preliminary design and to the requirements, implementation plans, data flows and interfaces, the plans for verification and validation, and security considerations. The topics for hardware include RMA, the design execution of the system functions, and the plans for testing. The corresponding system and segment level CDRs for each release will focus on interfaces and shall be Document Only reviews.

c. Test Readiness Reviews (TRRs) - For each release, TRRs will be conducted by the Project at the segment and element levels to review the plans for the integration and verification of the subsystems with the elements and the elements with their segments. The reviews should ensure that the tests will adequately verify the functional, performance, and interface requirements of the ECS.

d. Acceptance Test Readiness Review (ATRR) - For each release, the ATRR is conducted by the Project to review the plans for validation of the segments and the over-all system during the acceptance test program. The review shall cover the tests to verify the design requirements, as well as maintainability demonstrations for restoration of failed critical real-time functions.

e. Segment Operational Readiness Reviews - Segment Operational Readiness Reviews (Segment ORRs) shall be conducted by the contractor to determine the readiness of each ECS segment to provide services. These reviews shall be held at each segment/element facility to baseline the functional capabilities, performance, and operational characteristics of each ECS segment prior to the corresponding RRR. Segment ORRs shall concentrate on operational procedures, human interfaces, and the Operational Readiness Plan (DID 603/OP1).

f. Release Readiness Review (RRR) - For each release, the RRR will be conducted at the ECS system level by a GSFC Project Review Team. It will address the readiness of the release for installation in the ECS system. Review areas include integration test

results and acceptance test results, the success of implementation of the new capabilities and changes since the previous release, the status and adequacy of operations guides and users' documentation, the status of Distributed Active Archive Center (DAAC) interface and installation, and the plans for installation of the release into the ECS system in a manner that will minimize disruptions of ongoing service.

g. Capabilities and Requirements Review (CRR) - The CRR is an EOSDIS level review and will be conducted annually by a GSFC Project Review Team to assess the status of the EOSDIS system capability development to date in meeting the existing EOSDIS requirements and to refine design requirements for guiding further development activity.

2.4 SYSTEM SAFETY

System safety shall be an agenda item for each review (see par. 2.3) and shall emphasize: (a) hazards to personnel and facilities and (b) potential errors that can have adverse safety effects on the command and control of the flight system.

2.5 CONTRACTOR ASSURANCE REVIEW REQUIREMENTS

For each release, the ECS contractor shall conduct a program of planned and documented reviews within each ECS element at the subsystem, component, and lower levels and at appropriate milestones in the development process. This program shall include:

a. PDRs and CDRs - Each PDR and CDR shall be an intensive review of the design and internal interfaces to evaluate the ability of the subsystem (or other level) hardware and software concept and design to successfully perform its functions under operating conditions during both testing and operation.

b. Build reviews - The contractor shall conduct a series of build reviews covering the design of additional functionality to be added to the basic design and the plans for build testing. These shall be conducted before implementation of each build.

c. Subsystem test readiness reviews - Test readiness reviews (TRRs) shall be conducted at the subsystem level prior to the system-level TRR to review the adequacy of the subsystem designs and planned tests.

d. Acceptance test activity - Throughout the acceptance test phase, the contractor shall conduct reviews of results of selected increments of acceptance test activity. These reviews shall focus on the adequacy of the evaluation and the system portions evaluated to guide the need for any design modifications or test modifications.

Reviews shall be conducted by contractor personnel who are not directly responsible for the design. GSFC reserves the right to attend the reviews and requires notification and delivery of review materials in accordance with the CDRL (see Appendix C herein). The results of the reviews shall be documented, and a summary of each review shall be included in the Performance Assurance Status Report (par. 1.6) in accordance with the CDRL (see Appendix C herein). The review data shall be available to GSFC upon request.

2.6 SUPPORT OF GSFC FLIGHT MISSION READINESS REVIEWS

In addition to the reviews of the ECS identified above, the ECS contractor shall support a series of GSFC readiness reviews for each EOS flight mission. The support of this series of reviews by the ECS contractor shall relate to the role of the ECS in the conduct of the flight mission. These reviews include:

2.6.1 GROUND SYSTEM OPERATIONAL READINESS REVIEW (GSORR)

An operational Readiness review of the total EOS ground system will be conducted by a GSFC Assurance Review Team prior to each EOS flight mission. This review will certify the system's readiness for operation.

2.6.2 FLIGHT ASSURANCE REVIEWS

Prior to each EOS flight mission a series of Flight Assurance Reviews will be conducted by a GSFC Flight Assurance Review team, as follows:

a. Mission Operations Review (MOR) - This mission-

oriented review will normally take place prior to significant integration of the flight system. The purpose is to review the status of the system components, including the ground system and its operational interfaces with the flight system. Discussions will include integration and test planning.

b. Flight Operations Review (FOR) - This review will emphasize the final orbital operations plans, as well as the compatibility of the observatory with ground support equipment and ground network, including summary results of the network compatibility tests.

c. Flight Readiness Review (FRR) - This review is to assess the overall readiness of the total system to support the flight objectives of the mission.

3.0 VERIFICATION REQUIREMENTS

3.1 GENERAL

The philosophy and basic approach of a verification activity to ensure that the ECS meets its specified requirements is stated in the SOW and detailed in DID 401. As a part of this over-all effort, a system integration and test (I&T) program shall be conducted in accordance with the requirements of this section. The program shall consist of a series of tests, reviews, and analyses to ensure that the hardware, the software, and the integrated ECS perform as specified in all significant operating modes and mission situations. The system I&T program shall cover all verification of the hardware and software for each release prior to its fielding as a part of the ECS.

3.1.1 SYSTEM INTEGRATION AND TEST (I&T) PLAN

The contractor shall develop and document a plan for the I&T of each release of the ECS and its main segments and their composite elements against the specified design requirements. The plan shall describe the test, review, and analysis effort to be conducted at each stage of development of the system and each level of assembly of hardware and software to demonstrate that the item to be verified satisfactorily meets the portions or functions of the specified system design requirements that it is designed to perform. It shall stipulate the specific portions or functions of the system design requirements (including the various applicable operating modes and the pass/fail criteria) to be demonstrated by each of the planned tests and analyses. The software test plans (par. 3.3.3) shall be included as separate documents within, or by reference in the System I&T Plan. The Plan shall be iteratively updated to reflect system evolution throughout the development life cycle of the release, with each iteration reflecting the current stage of verification planning at the current delivery milestone stated in the CDRL (see Appendix C herein).

As an adjunct to the System I&T Plan for each release, an overall test matrix shall be prepared that summarizes all tests that will be performed within each ECS segment and element on each of its hardware components and subsystems, on each of its software units and subsystems, and on the combined hardware-software functional subsystems (This requirement is in addition to the "Performance Verification

Matrix" in the ECS Overall System Acceptance Test Plan - DID 409/VE1 required by the SOW). The contractor shall also maintain a matrix of the System I&T Program tests actually accomplished throughout the program for the release and present it at the pertinent GSFC reviews called for in Section 2. The I&T Plan (including the matrix of tests planned) and the matrix of tests accomplished shall be delivered to NASA and updated in accordance with the CDRL (see Appendix C herein).

3.1.2 VERIFICATION PROCEDURES

For each test activity conducted, verification procedures shall be prepared that describe the configuration of the item to be tested and how that particular test activity contained in the Verification Plan will be implemented.

The procedures for hardware verification (par. 3.2) shall describe details such as instrumentation monitoring, facility control sequences, test article functions, test parameters, quality control checkpoints, pass/fail criteria, data collection, and reporting requirements. For software, the procedures shall include analogous pertinent details (see par. 3.3.5) and shall implement the pertinent software test plan (3.3.3) for the software in question. For all verifications, the procedures shall address safety measures to protect the hardware and personnel (see paragraphs 4.4 and 4.5). Verification Procedures shall be submitted to NASA in accordance with the CDRL (see Appendix C herein).

3.1.3 CONTROL OF UNSCHEDULED ACTIVITIES DURING VERIFICATION

A documented procedure shall be established for controlling, documenting, and approving all activities not part of an approved verification procedure or software test procedure. The contractor shall be alert to the hazard potential of last minute changes and shall institute controls at appropriate management levels to prevent accident or injury or hardware damage. Such control shall include appropriate real-time decision making mechanisms to expedite continuation (or suspension) of testing after a malfunction, with documented rationale. The control procedure shall be documented in accordance with the CDRL (see Appendix C herein), and it shall be referenced in the PAIP (l.3) and in each verification procedure.

3.1.4 VERIFICATION REPORTS

After completion of each verification activity, a report shall be submitted in accordance with the CDRL (see Appendix C herein). For each hardware test activity, the report shall contain, as a minimum, the information described in the sample test report (see Figure 3-l) using a suitable reporting format. For software tests, an analogous report format shall be used to provide the information required by par. 3.3.5. For each analysis activity performed on either hardware or software, the report shall describe the degree to which the objectives were accomplished and other significant results. Detailed test and analysis data supporting the verification reports shall be retained by the contractor; this data, as well as the as-run verification procedures, shall be available for review at the contractor's facility upon request.

3.2 HARDWARE VERIFICATION

3.2.1 UNIT LEVEL COTS HARDWARE

Each unit of the ECS COTS hardware shall be verified at procured-unit level to the requirements of its procurement specification. Automated data processing (ADP) hardware covered by General Services Administration (GSA) acceptance criteria shall be acceptance tested in accordance with those criteria. All specified performance parameters shall be verified by test, and reliability/maintainability data shall be verified insofar as practicable by review and analysis. Manufacturer's operating system software and peripheral hardware shall be verified using manufacturer's diagnostic software wherever applicable.

3.2.2 CUSTOM DESIGNED, FABRICATED OR MODIFIED HARDWARE

Any hardware developed (custom designed), fabricated or modified by the contractor shall be verified by test to ensure that it performs its functions correctly, meets specified requirements, and is free of workmanship defects. The tests shall be performed at appropriate levels of assembly.

3.2.3 SUBSYSTEM LEVEL

Each operative hardware subsystem shall be verified by test and analysis to ensure that this level of the system hardware design is properly integrated and meets its performance

requirements. The contractor shall develop suitable test software designed to exercise the significant hardware functions of each subsystem and use it for the subsystem verifications.

LIST OF INFORMATION FOR HARDWARE TEST REPORTS

TEST ITEM IDENTIFICATION:

IS THE ITEM COTS OR CUSTOM:

MANUFACTURER:

SERIAL NUMBER:

LEVEL OF ASSEMBLY:

TYPE OF TEST AND BRIEF STATEMENT OF PRINCIPAL OBJECTIVE:

I&T PROCEDURE NO.:

IS THIS INITIAL TEST OR RETEST:

IDENTIFYING DESIGNATION OF THE APPLICABLE PART OF THE SYSTEM I&T PLAN:

SIGNATURE LINES FOR TEST CONDUCTOR, QUALITY ASSURANCE REPRESENTATIVE, AND COGNIZANT ENGINEER FOR THE ITEM:

DEVIATIONS, IF ANY, FROM TEST PROCEDURE:

DESCRIPTION OF EACH TEST NONCONFORMANCE AND NONCONFORMANCE REPORT NUMBER:

DESCRIPTION OF ANY UNSCHEDULED EVENTS OCCURRING DURING TEST:

TEST RESULTS AS COMPARED TO TEST CRITERIA:

Figure 3-1

3.3 SOFTWARE VERIFICATION AND VALIDATION (V&V)

3.3.1 GENERAL

The ECS contractor shall plan and implement a verification and validation process to demonstrate that the software is correct and meets its requirements. The process shall address each unit of the software system at each stage of its development and shall include walkthroughs or inspections, reviews, and testing.

3.3.2 WALKTHROUGHS OR INSPECTIONS

The complete V&V process includes walkthroughs or inspections on requirements, detailed design, and code. These are conducted to find errors or omissions throughout the development process.

Code walkthroughs or formal inspections shall be conducted prior to the integration and test of each software unit. These walkthroughs shall verify that the source code conforms with the established programming standards, conventions and practices and that the code accurately implements the design established in the design and requirements documents.

The walkthroughs shall be documented. V&V also includes the program of internal and external reviews, covered in Section 2 of this document.

3.3.3 SOFTWARE TEST PLANS

For the software system of each element of each segment, the contractor shall develop a software test plan to describe the verification activities and tests to be conducted at the unit and higher levels of the software during the integration and test (I&T) phase and during the acceptance test phase. The plan shall describe the specific requirements and design features of the product specification to be demonstrated by each test, as well as the test criteria. It shall show the verification process, including hardware-software integration tests, that will be used to demonstrate that the software meets its requirements. The plan shall include the environment under which the test is to be conducted, the design requirements for the item tested, the data required for the test, the expected results, and any special operating conditions required. The plan is to be updated as requirements are updated and shall be included as part of

each applicable review required in Section 2. The plan shall also describe any special test support tools (i.e.,

simulators, emulators, etc.) needed for the testing and any required support from other organizations to perform the testing.

The software test plans shall be submitted and updated in accordance with par. 3.1.1.

After GSFC acceptance of any revision level of a software item, all changes shall require issuance of a new or revised test plan in accordance with the requirements of the Project configuration management system. If the software is updated, regression testing is required and shall be so identified in the test plan.

3.3.4 SOFTWARE TEST PROCEDURES

For each software test under the verification program, a software test procedure shall be prepared. The procedure shall describe the specific requirements and design features to be demonstrated by the test as well as the test criteria. The procedure shall also detail the steps and procedures necessary to conduct the test, including special instructions for conducting the test and for responding to problems or anomalies that may be encountered. The procedures shall at least include items detailed in par. 5.0 of SMAP-DID-A200. (See also par. 3.1.2 and 3.3.3, above.)

3.3.5 SOFTWARE TEST REPORTS

For each test the contractor shall prepare a software test report that summarizes the software I&T test or acceptance test and/or retest conducted. The report shall show as a minimum, the identification of the software article tested, the type of test, the design requirements, conformance of the test results to the expected results (verification of requirements), the number, type and criticality of the discrepancies found, the test scenarios used to test for unsatisfactory performance, and the identification of verification activity being performed on functionally interrelated software items. The detailed test results shall be documented by the contractor and shall be available for GSFC review. Software test reports shall be provided in accordance with par. 3.1.4.

3.3.6 CRITICAL SOFTWARE ITEMS TESTING

For software items, the special testing requirements

identified in critical software items analysis (see par. 6.4), shall be given appropriate attention in the V&V process. These requirements shall be included in appropriate tests under the verification program and in other V&V activities to further assess the potential effects of the risks identified and the measures used to minimize them. The critical software items testing effort shall also include testing requirements related to safety issues identified in the hazard analyses (par. 4.3).

3.3.7 VERIFICATION AND INTEGRATION OF MODIFIED OR NEW SOFTWARE

For modified or new software developed in sustaining engineering activity during the operational phase, integration tests are required to ensure that introduction of the software is accomplished with minimum impact to ongoing ECS operations.

3.4 END-TO-END TEST REQUIREMENTS

3.4.1 COMPATIBILITY TEST

Prior to the conduct of the EOS flight missions, an end-to-end compatibility test will be conducted using all portions of the operational system; namely, the Observatory, the operational software, and the ground system, including the ECS and the appropriate network elements in order to fully demonstrate operational compatibility so that the entire system will perform as required for the mission. When acceptable simulation facilities are available for portions of the operational system they may be substituted for the actual system element. The tests will be conducted by the EOS Observatory contractor. The ECS contractor shall support these tests.

3.4.2 MISSION SIMULATIONS

After completion of the end-to-end compatibility test, data flow tests shall be performed utilizing the total system in a realistic mission timeline, including external stimulus of the instruments and attitude control sensors, when practicable.

Telemetry and command demonstrations shall be conducted, incorporating all the required equipment: appropriate Network elements, NASCOM, the ECS (including the EOC and

ICF), data processing facilities (Observatory and ECS), and, when available, the users' Instrument Support Terminals. Once the data flow paths have been verified, mission simulations shall be held to validate nominal and contingency mission operating procedures and to provide for operator familiarization training. Instrument developers will participate in mission simulations. The mission simulations will be the responsibility of the EOS Observatory contractor. The ECS contractor shall support the simulations as necessary.

4.0 SYSTEM SAFETY

4.1 GENERAL REQUIREMENTS

The contractor shall plan and conduct a system safety program that accomplishes the following items.

a. Provides for the identification and control of hazards (emanating from the ECS) to personnel and facilities during the development, maintenance, and operation of the ECS. The program shall also address command and control of EOS operations on-orbit that could present a hazard to personnel or facilities in orbit or on the ground.

b. Interfaces effectively with the industrial safety requirements of the contract and the contractor's existing safety organization.

4.2 SYSTEM SAFETY IMPLEMENTATION PLAN

The contractor shall prepare and submit a System Safety Implementation Plan that constitutes Section 4 of the PAIP. Contractor documents referenced therein shall be submitted with the Plan.

The System Safety Implementation Plan shall describe the safety program requirements and implementation procedures the contractor is to follow to ensure the identification and control of hazards to personnel and facilities during design, fabrication, integration, test, and operations.

The plan shall address the planned effort and approach that will be used to implement each activity included in this Section. It shall include a description of the following:

a. system safety organization, interfaces, and responsibilities;

b. milestone schedule of all major system safety activities which shows their time-phasing with other related major activities;

c. system safety methodologies;

d. internal and external safety review process;

e. safety review of test and operating procedures;

f. hazardous operations surveillance;

g. accident investigation and reporting;

h. training and certification;

i. safety audits;

j. monitoring of subcontractors;

k. documentation to be provided;

m. procedure for reporting problems and activity status;

n. industrial safety engineering responsibilities and functions and their interfaces with the system safety program.

4.3 HAZARD ANALYSES

Early in the design phase and continuing throughout the contract effort, the contractor shall develop documented analyses identifying both hardware and software hazards for each element and segment in the ECS:

a. In the hardware area, the analysis shall include the ECS facilities and their operations and shall identify hazards to personnel, the equipment, and facilities;

b. In the software area, the analyses shall focus on the software critical items (see par. 6.4 and Appendix B) and examine the potential malfunctions (hazards) of the critical items (including on-orbit operations) that can result in injury to personnel or damage to the flight hardware.

The contractor shall take measures to eliminate or minimize the effect of each significant identified hazard. The analyses shall be updated as the ECS program progresses through its development, test, and operational use. The hazard analyses shall be submitted in accordance with the CDRL (see Appendix C herein).

4.4 HAZARD CONTROL VERIFICATION

Verification of the control of identified hazards shall be accomplished by test, analysis, and inspection. The contractor shall identify the method and activity to be used for each hazard on the respective hazard analysis report, including identification of specific analyses or tests (cross

referenced to the verification plan) to be used (see also par 3.3.6).

4.5 REVIEWS

Presentation of the status of the safety program, and particularly the status of efforts to identify, correct, and/or contain problems on critical items, shall be included in each GSFC review and each contractor review conducted in accordance with Section 2, above.

5.0 RELIABILITY, MAINTAINABILITY, AVAILABILITY (RMA) REQUIREMENTS

5.1 GENERAL REQUIREMENTS

The contractor shall establish and maintain a reliability, maintainability, availability (RMA) program designed to ensure that the delivered system meets the specified operational availability (Ao) requirements for the functions of the ECS (see the ECS F&P Specification) (Appendix A). The program shall be oriented toward design development, guiding engineering trade-offs, and evaluating the system design. The program shall emphasize both integration and operational use of the ECS. The reliability and maintainability (R&M) tradeoff in the design shall rely on vendor supplied R&M data where available, augmented as necessary by analysis, and shall be updated to reflect any experience data available.

The RMA program shall consist of RMA tasks which are planned, integrated, and accomplished in conjunction with the implementation of the design, development, manufacturing, and operational requirements. RMA engineering tasks shall focus on the determination of a system configuration of COTS and custom designed components which meets RMA goals/requirements and the establishment of a maintainability approach and basis for a maintenance plan optimized to the operational availability requirements for functions of the ECS. Reliability and maintainability engineering shall be an integral part of the process used to guide design tradeoffs of redundancy and serviceability and to guide operational maintenance planning.

5.2 RMA PROGRAM PLAN

The contractor shall develop an RMA Program Plan which will describe the planned approach for the coordinated program of reliability and maintainability activities for the ECS. The plan shall be included in the PAIP and shall describe the effort for each of the RMA tasks and their scheduling relative to ECS program milestones.

5.3 RELIABILITY ANALYSES

Reliability analyses shall be performed concurrently with design so that identified problem areas can be addressed for timely consideration of corrective action. The analyses shall be based on vendor-supplied unit reliability data at

the purchased-hardware-unit or custom-designed-component level or at lower levels of assembly if credible data is available. Where credible reliability data at the "line replaceable unit" (LRU) level are not available, the contractor shall provide reliability estimates at the LRU level. Such estimates shall be based on technically credible assumptions, and their derivation shall be documented with the analyses (see par. 5.3.3).

5.3.1 MODELING FOR SYSTEM AVAILABILITY

The contractor shall develop a mathematical model to represent an ECS design which meets specified availability goals for the system functions. For purposes of the analysis, assumed availability goals (with supporting rationale) shall be supplied for those functions lacking a specified goal/requirement which are essential to support a reasonable system model. The modeling shall include the development of functional block diagrams and shall be performed for each segment and element in the ECS and for each operating function of each element. The models shall be based on allocation of reliability to the functions within the ECS design and shall employ the vendor-provided unit reliability data for the COTS hardware and derived reliability data for custom designed components making up the system design. While the model shall represent the overall ECS, software "reliability" shall be represented by a reasonable estimate (with supporting rationale), and the tradeoff/allocation activity shall emphasize the hardware reliability and maintainability and include operational considerations. Redundancy decisions and spares provisioning (logistics planning) shall be based on reliability and maintainability analyses (see also the ECS F&P Specification) (Appendix A). The modeling activity shall be initiated early in the program and continued throughout the operational phase of ECS and shall be used to analyze effects of: (a) any design changes occurring as a result of sustaining engineering activity, or (b) maintenance activities or (c) aging.

The modeling outputs shall be expressed in terms of mean time between failures (MTBF), mean down time (MDT), mean time to repair (MTTR), and operational availability (Ao). The models shall be updated with information resulting from reliability and other relevant tests as well as design or operational changes (including any changes in mission parameters or operational constraints). The availability models shall

include a statement of the underlying ground rules and assumptions and be submitted in accordance with the CDRL (see Appendix C herein).

5.3.2 RELIABILITY ALLOCATIONS

Top level ECS RMA requirements shall be allocated to the level of repair and maintenance and shall be used to establish baseline requirements for designers. Requirements consistent with the allocations shall be imposed on the subcontractors and suppliers. All allocated reliability values established by the contractor and included in contract end item specifications shall be consistent with the availability models and any changes thereto, and be subject to GSFC review.

5.3.3 RELIABILITY PREDICTIONS

Reliability predictions are required to support the modeling activity(par. 5.3.1, above). Where vendor-supplied reliability data at the purchased-hardware unit level (or at lower levels of assembly, in selected cases) are not available, or in the case of custom designed hardware, the contractor shall make the reliability predictions. Predictions shall account for, and differentiate between, each significant mode of item operation. The predictions for electronic equipment shall be made using vendor-supplied reliability data and/or schematic diagrams and the Parts Count Analysis method and failure rate data contained in Appendix A of MIL-HDBK-217. Predictions for mechanical, electrical, and electromechanical equipment shall be made using vendor-supplied data; where such data are not available, the contractor shall make estimates using his data sources and NPRD-3 (see Appendix A). The predictions and allocations shall be kept mutually consistent. The predictions, including a statement of the underlying ground rules and assumptions, shall be presented at the pertinent design reviews (see par. 2) and be submitted in accordance with the CDRL (see Appendix C herein). CH01

5.3.4 FAILURE MODES AND EFFECTS ANALYSIS AND CRITICAL ITEMS LIST

A failure modes and effects analysis (FMEA) shall be performed to identify potential catastrophic and critical failures (see Appendix B) in the critical command and control systems of the Flight Operations Segment (FOS) so that

susceptibility to the failures and their effects can be eliminated. A listing of all failure modes and severity level of the failure effects shall be provided.

The FMEA process shall focus on the interfaces and on any custom designed hardware of the systems being analyzed. It shall be performed iteratively, as required, starting early in the design phase to ensure that the design and changes resulting from design reviews, analyses, waivers/deviations, operations changes, sustaining engineering activity, or other reasons do not introduce unrecognized new failure modes or criticalities into the system.

In the software area, an analogous analysis activity is described in par. 6.4. CH-03

The FMEA shall be conducted at the equipment level LRU, or equipment level, for the critical FOS functions. Potential catastrophic and critical failure modes shall be analyzed to the extent necessary to identify single LRUs that could cause the failures. Each FMEA shall be performed in accordance with GSFC S-302-89-01 "Failure Modes and Effects Analysis Procedures for Unmanned Spacecraft and Instruments" or a contractor procedure that has been approved by the Contracting Officer. Because ECS does not have a 2-fault tolerance requirement, for purposes of the FMEA, the failure mode criticality classifications in GSFC S-302-89-01 shall be modified to read as follows: CH-03

> Criticality 1. A single failure that could result in loss of human life, serious injury to personnel, loss of mission, or loss of observatory or a major portion of an ECS facility.

Criticality 2. A single failure that could result in loss of a primary mission objective (as defined by the Project) or significant damage to the observatory.

Criticality 3. A single failure that could result in loss of a secondary mission objective (as defined by the Project), significant damage to an instrument or degradation of science products (as defined by the Project), or loss of data identified as critical by the Project.

> Criticality 4. Loss of system capability that does not significantly impact the science mission.

Analysis of redundant equipment shall address cross-strapping

to ensure that no single failure will adversely affect the performance of the redundant capability. No single failure shall prevent the successful removal of power from a failed flight instrument, and the FOS shall have no single failure points in the components that provide critical real-time functions. Potential catastrophic (Criticality 1 or 2) failures that cannot be eliminated from the system, and all potential critical (Criticality 3) failures, shall be itemized on a Critical Items List (CIL) that shall be attached to the FMEA. Justification for retention of each item listed shall be included.

The FMEA with the attached Critical Items List and updates shall include a statement of the underlying ground rules and

assumptions and be submitted to NASA in accordance with the CDRL (see Appendix C herein).

5.4 MAINTAINABILITY ANALYSES

Maintainability analyses shall be performed concurrently with design so that identified problem areas can be addressed for timely consideration of corrective action. The maintainability analyses shall be based on the MTBF data produced in the reliability analyses for the LRU level of the hardware and the required availability for each major ECS function. The analyses shall focus on mean down times (to restore failed functions), with separate identification of mean times to repair and mean times for associated delays (including repair scenarios).

The maintainability analyses shall be used in appropriate tradeoffs to establish the ECS maintenance concept and maintainability plan and to determine spare parts/units requirements.

5.4.1 MAINTAINABILITY ALLOCATIONS

Mean-Time-To-Repair (MTTR) requirements throughout the system, derived from tradeoffs shall be identified and documented in the maintainability predictions (see par. 5.4.2). The MTTR requirements shall be broken down to the line replaceable unit (LRU) level to establish requirements for logistics planners. The top level of maintainability requirements shall be allocated to the planned levels of repair. Requirements consistent with the allocations shall be imposed on the subcontractors and suppliers.

5.4.2 MAINTAINABILITY PREDICTIONS

Maintainability predictions shall be made showing the capability of the system/component/LRU to meet the allocated MTTR and/or specified mean down time requirements. The predictions shall be made using MIL-HDBK-472, Prediction Procedure II. The predictions should consider and identify pertinent requirements for accessibility and shall consider human factors. The predictions shall include a statement of the underlying ground rules and assumptions and be submitted in accordance with the CDRL (see Appendix C herein).

5.4.3 FMEA MAINTAINABILITY INFORMATION

For each failure mode identified in the FMEA (see par. 5.3.4), the contractor shall identify failure detection means and basic maintenance action information to support the

maintainability data collection and analysis activity (see par. 5.5).

5.4.4 MAINTAINABILITY DESIGN AND OPERATING STANDARDS

The contractor shall develop, document and use design standards to facilitate maintainability of the system and maintenance operations. This shall include such factors as accessibility and human factors considerations (e.g. dealing with LRU weight and bulk) as well as engineering of equipment and cabling layout, junction/access boxes, cable identification labeling every 6 feet for traceability, and power-shut-off security (for maintenance personnel safety). These standards shall also include requirements for discipline and control to prevent unauthorized access to equipment, and to maintain logs and other records to track each access and each maintenance operation and provide traceability to the individuals involved.

5.5 MAINTAINABILITY DATA COLLECTION AND ANALYSIS

The contractor shall establish a maintainability data collection system to augment and update predictions with preliminary trial results during design, for measurement and evaluation of demonstration results, and to track actual operations maintenance experience and trends. Maintenance records (see par. 7.16) shall include experience data on such items as operating time logs, failure frequency, repair times, total down time for each maintenance event, and adequacy of sparing provisions. Data collection should be integrated as much as possible with similar data collection requirements, such as reliability.

The data collection system shall be used as a means for identifying maintainability design problems/errors and initiating corrective actions. Procedures shall be identified for: providing inputs to the system; the analysis of problems; and feedback of corrective action into the design, manufacturing, integration and test, and operational maintenance planning processes.

5.6 MAINTAINABILITY DEMONSTRATION

The contractor shall use the reliability predictions and other pertinent considerations to identify and list the most probable anticipated failures of critical real-time system functions (primarily in the FOS). From this list, the

contractor shall identify and scope a group of candidate maintainability demonstration tests from which a selection will later be made of specific tests to conduct as a part of the acceptance test program.

The objective of the demonstrations is to verify the capability of the planned maintenance activities to meet the operational availabilities/mean down times stated in the ECS F&P Specification for identified system functions. Other objectives of the tests are to evaluate the adequacy of fault detection or isolation methods and the ability to achieve LRU replacements or on-site repairs to meet criteria stated in the Maintenance Plan.

The demonstrations shall be conducted generally in accordance with Task 103 of MIL-STD-470. The demonstrations of on-site maintenance shall be limited to "Phase II" (MIL-STD-471) activity; demonstration of depot maintenance activities is not required.

The contractor shall describe the planned activities in a Maintainability Demonstration Plan (MD Plan). The Plan shall describe candidate failure scenarios and identify and outline the test specification requirements of each candidate individual demonstration. Selection of candidates shall be made subsequently by an independent contractor organization (IATO) responsible for the acceptance test program. When the selection has been made, detailed test plans shall be documented by the IATO and used in the demonstration tests.

The Demonstration Plan, demonstration test plans, and reports of test results shall be submitted in accordance with the CDRL (see Appendix C herein). Reports of the results of each individual demonstration test shall contain pertinent information including:

a. Test number and designation in the MD Plan

b. Scenario description;

c. Failure introduced;

d. Time and method to detect existence of a malfunction;

e. Time to isolate to correct LRU, and diagnostic tools used;

f. Availability and storage location of spare LRU and of repair tools;

g. Time to fetch spare;

h. Repair time;

i. Formal checkout procedure used, and number (if existing);

j. Custom-generated procedure used and authority;

k. Total down time and specified maximum allowable down time.

5.7 CONTROL OF SUBCONTRACTORS AND SUPPLIERS

The contractor shall ensure that system elements (at all ECS locations) obtained from subcontractors and suppliers will meet the pertinent ECS RMA requirements. All subcontracts shall include provisions for review and evaluation of the subcontractors' and suppliers' RMA efforts by the prime contractor at the prime contractor's discretion, and by GSFC at its discretion.

The contractor shall tailor the RMA requirements of this document in hardware and software subcontracts for ECS and shall exercise necessary surveillance to ensure that subcontractors' and suppliers' RMA efforts are consistent with overall system requirements. The contractor shall, as a result of this tailoring: | CH06 | CH06

a. Incorporate quantitative RMA requirements in subcontracted equipment specifications;

b. Assure that subcontractors have RMA programs that are compatible with the overall program;

c. Review subcontractors' assessments and analyses for accuracy and correctness of approach;

d. Review subcontractors' test plans, procedures, and reports for correctness of approach and test details;

e. Attend and participate in subcontractors' design

reviews.

f. Ensure that subcontractors during the ECS operational phase comply with the applicable system RMA requirements.

5.8 RMA OF GOVERNMENT-FURNISHED EQUIPMENT (GFE)

When the overall ECS includes components or other elements furnished by the Government, the contractor shall be responsible for identifying and requesting from the EOS Project Office adequate RMA data on the items. The data will be used for performing the RMA analyses (par 5.3 and 5.4). When examination of the data or testing by the contractor indicates that the reliability or maintainability of GFE is inconsistent with the RMA requirements of the overall system, the EOS Project Office shall be formally and promptly notified.

6.0 SOFTWARE ASSURANCE REQUIREMENTS

6.1 GENERAL REQUIREMENTS

The contractor shall establish a program of software assurance that includes verification and validation (see Section 3), quality assurance, configuration management, and nonconformance reporting and corrective action. This software assurance program shall be coordinated with the hardware and system oriented assurance program established to meet the requirements identified in this PAR. The software assurance program shall encompass any software developed, procured or used under this contract (except COTS software and prototype software used only to help in requirements definition), including mission operations system software and firmware, and ground support equipment software. These requirements also apply to any software written or modified by the ECS contractor, including key parameter software, software for ground processing of data, and science and data analysis software which the contractor has been tasked to write.

The contractor's plan for implementation of the software assurance program, including the description of the software management and assurance approach that will be followed, the methods to be used, and a reference listing of the procedures and other documents to be used shall be provided in the software section of the PAIP (see par. 1.3). The PAIP shall address or provide by reference each of the following:

a. A description of the software to be developed.

b. Management structure and responsibilities of the organization(s) developing and assuring the software, and its (their) relationship to the hardware and systems development activities of the project.

c. The software requirements development and control process, including the process for identification and control of interfaces.

d. The software design and implementation process, describing the major steps that are to be followed in detailing the design and implementation.

e. An overview of the assurance process for software

development and its application to the specific software to be developed. If different management and assurance practices will be used for certain of the software that is deemed more critical than other software, these shall be described.

f. Software management and assurance activities of the project which support or interrelate to implementation of the requirements of this Section.

g. Software standards, guidelines, and procedures to be followed, including procedures governing the system of software development documentation and record keeping. Also, a description of software development tools to be used.

6.1.1 DOCUMENTATION

The contractor shall provide a list of the documentation to be produced for the software elements covered by this assurance requirement.

The contractor shall provide a schedule of the issuance of versions (i.e., revision levels) of the documentation in relationship to the configuration management baselines required in paragraph 6.5.

6.1.2 CONTRACTOR ASSURANCE RESPONSIBILITY FOR SOFTWARE

The contractor is responsible for ensuring that all software used for ECS meets the requirements of this PAR document, as well as the functional, performance, and interface requirements placed upon it. This includes Government Furnished Equipment (GFE) software and purchased software. Any previously developed or modified software shall be subject to the requirements of paragraph 1.4, above. Paragraph 1.4,c also states the contractor's responsibilities for COTS software used for the ECS effort.

Any substantial modification to any component or module of the existing software shall be subject to all of the assurance provisions of this document. A substantial modification is defined as the change of twenty percent or more of the lines of code in a software component. However, the fact that a modification involves fewer than 20% of the lines of code in a component shall not be interpreted to relieve the contractor of the responsibility to apply an

appropriate level of management and assurance attention to its development, verification, and use. The stated "substantial" threshold has been selected as the point beyond which a loosely structured or abbreviated assurance effort is clearly inappropriate.

6.2 VERIFICATION AND VALIDATION

Verification and validation requirements are stated in paragraph 3.3, above.

6.3 SOFTWARE QUALITY ASSURANCE

6.3.1 STANDARDS

The contractor shall establish standards for software and project documentation, including the documentation of software designs and interface specifications. Unless otherwise approved, the contractor shall use appropriate portions of the NASA software documentation standards contained in the "Information System Life-Cycle and Documentation Standards" from the NASA Office of Safety, Reliability, Maintainability and Quality Assurance, (see Appendix A).

The contractor shall also set standards for code and for the internal documentation (e.g., code level comments).

The contractor shall review any standard product software provided by EOS Principal Investigators (Pis) and Facility Instrument (FI) Investigation Teams to ensure that it complies with standards established by the GS&O Project for Science Data Processing Software. The contractor shall also comply with these standards in his own activities on the ECS. Deviations shall be brought to Project attention.

6.3.2 ASSURANCE FUNCTION

The contractor shall have an assurance function which verifies that the standards required by par. 6.3.1 have been met. The assurance function shall also verify that the required design documentation, test, configuration management, and nonconformance reporting procedures and practices have been followed, and that walkthroughs or inspection provisions have been implemented.

6.4 CRITICAL SOFTWARE ITEMS ANALYSIS

As one aspect of implementing the risk assessment provisions of NHB 2410.9, the contractor shall perform analyses to identify the software computer program configuration items (CPCIs) that have a critical command, control, or data receiving/storing function, such that there is the risk of a CH05

malfunction resulting in damage to or loss of the flight hardware or the mission, including inability to produce or irretrievable loss of Essential Data Products (see Appendix B). These software, CPCIs, called "critical software items" shall be listed on a Critical Software Items List(s) for appropriate management attention and assurance program actions for each release. Updates are provided as required for any changes related to a release. CH05 CH05

For critical software items, the analysis process shall include a detailed analysis of the requirements and the design, followed by analysis of the code and by critical software items testing (see par. 3.3.6). The detailed requirements analysis shall be conducted to determine which portions of the requirements have the potential for critical error effects. This effort shall be complemented by analysis of the specifications and, for critical command functions, by timing, sizing, and throughput analysis, as appropriate. This critical software items analysis effort shall be used to maximize the testability of the design to facilitate identification of errors with critical risk potential. This effort shall identify special testing requirements and other appropriate V&V activities.

6.5 SOFTWARE CONFIGURATION MANAGEMENT

The contractor shall establish a software configuration management (CM) process to manage requirements, design, code, data, and documentation, and to control, track and report on the status of changes to them. This configuration management process shall include, as a minimum, the following elements:

a. Identification of the configuration items that will be baselined and maintained under configuration control.

b. Establishment of configuration management baselines. In addition to the Allocated Baseline (ABL) established at the time of the SRR, the contractor shall establish at least four additional baselines for each release, a Preliminary Design Baseline (PDBL) after the system PDR for each release (see Section 2), a Final Design Baseline (FDBL) established after system CDR, a Coded Baseline (CBL) after the ATRR for each segment and element, and finally, a Product Baseline (PBL) after the RRR for each release.

c. A change classification and impact assessment process. The process must result in Class 1 changes, as defined in the Earth Observing System Configuration Management Plan (CMP) (GSFC 420-02-02), being forwarded to GSFC for disposition. Class 1 changes are defined as those which affect system requirements, software requirements, system safety, reliability, cost, schedule, and external interfaces.

d. A Configuration Control Board (CCB) that reviews and dispositions changes. A quality assurance representative shall be a member of the CCB.

e. Version (i.e., revision level) control and media labelling methods and procedures.

f. Physical control of master media to prevent unauthorized access or changes to the baselined software.

The contractor shall establish procedures that detail the steps to accomplish the CM process, including any needed forms and associated processing.

6.6 SOFTWARE NONCONFORMANCE REPORTING AND CORRECTIVE ACTION

The contractor shall establish a process for the reporting, analysis, correction, and closure of nonconformances discovered in the software and software documentation. The process shall be documented in written procedures.

Formal reporting of software nonconformances for each software item (product) shall begin with the establishment of its initial baseline and shall interface with the software configuration management process such that change control is effected, and that reported nonconformances and change requests are so identified and processed. This shall be accomplished by the establishment of a formal contractor mechanism(s) to disposition reported software non-conformances. For any baselined product the applicable CCB shall be used. The contractor shall notify the cognizant NASA representatives 10 days in advance of, and make provision for their attendance (at NASA option) at the CCB or

dispositioning body meetings.

Between element CDR and ATRR, the formal reporting and corrective action process shall also be applied to each software coded item, starting at the beginning of integration and test activity with that item.

For software nonconformance reporting, an appropriate format shall be used which includes at least the following minimum set of data items:

a. Unique report identification number;

b. Software product identification (including version number);

c. Originator

d. Origination date;

e. Report title (i.e., very brief description of the nonconformance);

f. Nonconformance summary (fuller description of the nonconformance).

g. Status (progress toward closure);

h. Nonconformance source (e.g., hardware, firmware, software, etc.);

i. Nonconformance criticality level (see par. 7.12.2.3). | CH08

j. Proposed corrective action;

k. Corrective action taken (including version identification of the corrected product and date);

l. Test verification of corrective action (and date);

m. Closure date and authority signature.

The contractor may use his own form and system for reporting if it complies with the requirements of this paragraph and is approved by the Contracting Officer. The contractor shall provide copies of the formal software nonconformance reports to NASA in accordance with the CDRL (see Appendix C herein).

The information shall be provided in the same hard copy and computer readable forms as prescribed for Malfunction Reports in par. 7.12.2. The contractor shall also maintain a master report file on formally reported software nonconformances analogous to that required for malfunctions (see par. 7.12.2) and shall provide status summaries on open software nonconformance reports (similar to that for malfunctions - see par. 7.12.2.b) as part of the Performance Assurance Status Report (par. 1.6).

Starting at the beginning of software acceptance testing (of each software item) with the ECS system hardware, software nonconformances shall be reported and processed under the system-level malfunction reporting system (see par. 7.12.2).

6.7 SECURITY [moved from safety section]

The contractor shall review all software and hardware to determine its sensitivity to potential harm to EOSDIS functions that can result from loss, tampering, or misuse (see also the ECS F&P Specification and NHB 2410.9). Any whose sensitivity is considered to be "significant" shall be identified on a security list. For each listed item, the list shall show the potential types of interference that can occur, their impact, and measures planned for security control. The list and the security measures shall be subject to NASA review. The list shall be submitted in accordance with the CDRL (see Appendix C herein)

7.0 HARDWARE QUALITY ASSURANCE REQUIREMENTS

7.1 GENERAL REQUIREMENTS

The contractor shall maintain an effective and timely quality assurance (QA) program that is planned and developed in conjunction with all other contractor functions as necessary to satisfy the contract requirements. The program shall:

a. Demonstrate recognition of the quality aspects of the contract and the importance of using an organized approach to achieve them;

b. Ensure that quality requirements are identified, established, and satisfied throughout all phases of contract performance, including design, development, fabrication, processing, assembly, inspection, test, packaging, shipping, storage, maintenance, and mission use, as applicable;

c. Provide for the detection of actual or potential deficiencies, system incompatibility, marginal quality, and trends or conditions which could result in unsatisfactory quality;

d. Provide timely and effective remedial and preventive action;

The status of the quality assurance program shall be reported in accordance with par. 1.6.

7.2 QUALITY ASSURANCE PLAN

The contractor shall develop a quality assurance (QA) plan as Section 7 of the PAIP (see par. 1.3) which will describe the detailed tasks to be performed in implementation of the requirements of this Section of the PAR. The plan shall clearly describe the activities applicable to: (1) COTS hardware, (2) "new hardware" (new design, new build, or modification of existing hardware), and (3) those applicable to integration, test, maintenance, and operation of the ECS. For each pertinent maintenance activity under the ECS Maintenance Plan (DID 613/OP3) and for each pertinent operations activity under the ECS Operations Plan (DID 608/OP3), the QA Plan shall identify appropriate related QA actions.

7.3 DOCUMENT CHANGE CONTROL

The contractor shall ensure control of all documents and revisions thereto that affect the hardware and software. Quality assurance personnel shall ensure that documents and revisions are controlled in accordance with the Earth Observing System Configuration Management Plan GSFC 420-02-02. Any software (except COTS software) that is imbedded in custom built hardware shall be subject to the appropriate requirements of Section 6, herein and the other pertinent requirements of this PAR document. The contractor shall ensure that the effectivity of documents and revisions are clearly specified, revisions are accomplished on affected product, and revised product is appropriately identified. Documents shall be kept current to ensure that all fabrication, inspections, and tests are performed according to the most recent drawings and revisions. The inspection record of the product shall indicate the level with which it is in compliance.

For all hardware except COTS hardware, the drawing and revision level of the drawings and specifications to which the particular product has been fabricated, inspected, and tested shall be documented as the as-built configuration. Evidence shall be provided of compliance with the as-built documentation as a basis for acceptance of the hardware. This information shall be submitted as part of the Acceptance Data Package (see par. 7.22).

A contractor quality assurance representative shall be a permanent member of the Configuration Control Board. The QA activities shall be defined in the Configuration Management Plan and described in detail in the QA Plan; related portions of the plans shall be cross-referenced.

7.4 IDENTIFICATION AND TRACEABILITY REQUIREMENTS

The contractor shall maintain a product identification and tracking system. Each product shall be identified by a unique part or type number, consistent with the configuration management system for the contract. Where control of individual products or lots of products is required, date codes, lot numbers, serial numbers, or other identification shall be used as appropriate. COTS hardware shall be traceable initially to the separate-unit level (drawing number and serial number), and after any maintenance activity, traceability shall be to the replaced LRU level.

If any LRUs are stocked as spares, all like articles shall be traceable initially (including those installed in the higher level assembly.

7.5 PROCUREMENT REQUIREMENTS

The following detailed quality assurance requirements, as applicable, shall be included or referenced in the procurement documents, in addition to those requirements selected in conformance with paragraph 1.8.2.

7.5.1 PRODUCT CHANGES

For custom products the supplier shall notify the contractor of proposed changes to products (including changes in design, fabrication methods, processes or location, and changes which may affect the quality or intended end use of the item). The supplier shall submit these changes to the contractor for processing in accordance with the contractor's configuration management plan. When a proprietary item is procured by the contractor, the supplier shall also notify the contractor of those changes. | CH06

For COTS products the contractor shall ensure that vendor/ supplier changes have no impact to the quality or end use of the item prior to incorporation of the change. | CH06

7.5.2 AGE CONTROL AND LIMITED-LIFE PRODUCTS

Records shall be kept on products that have definite characteristics of quality degradation or drift with use, age or storage conditions. These shall include any materials to be used in fabrication or maintenance or to age-limited materials or recording media used in data recording or archiving. The records shall note the date, test time, or cycle when useful life was initiated, the life or cycles used, and the date, test time, or cycle when useful life will be expended.

7.5.3 INSPECTION AND TEST RECORDS

The contractor shall specify that the supplier maintain inspection and test records as evidence of inspection and test results. The contractor shall also specify records that are to be provided with the deliverable item.

7.5.4 GOVERNMENT SOURCE INSPECTION (GSI)

When the Government elects to perform inspection at a supplier's plant in accordance with paragraph 7.7, the following statement shall be included in the procurement document:

"All work on this order is subject to inspection and test by the Government at any time and place. The Government quality representative who has been delegated NASA quality assurance functions on this procurement shall be notified immediately upon receipt of this order. The Government representative

shall also be notified 48 hours in advance of the time that articles or materials are ready for inspection or test."

7.5.5 PROCUREMENTS THAT DO NOT REQUIRE GOVERNMENT SOURCE INSPECTION (GSI)

Procurements that do not require GSI shall include the following statement:

"The Government has the right to inspect any or all of the work included in this order at the supplier's plant."

7.5.6 CONTRACTOR QA ACTIVITY AT SOURCE

When contractor QA activity is required at a supplier's plant as determined by paragraph 7.8, the procurement document shall so indicate.

7.5.7 RESUBMITTING OF NONCONFORMING ARTICLES OR MATERIALS

Nonconforming articles and materials returned to the supplier by the contractor and subsequently resubmitted by the supplier shall bear adequate identification of such resubmitting. Reference shall be made to the contractor's nonconformance document, and evidence provided that the causes for the nonconformance have been identified and corrected and actions have been taken to preclude recurrence. All resubmitted products shall be subjected to reinspection and test.

7.6 REVIEW AND APPROVAL OF PROCUREMENT DOCUMENTS

Quality assurance personnel shall review and approve procurement documents before their release to ensure that applicable requirements of this document are included. The reviews shall be documented.

7.7 PROCUREMENT REVIEW BY THE GOVERNMENT

The contractor shall forward procurement documents to the Government representative to review for compliance with contract requirements and to determine the need for Government source inspection. Such Government inspection shall not replace contractor source inspection or relieve the contractor of his responsibilities for product reliability, quality, and safety.

7.8 CONTRACTOR SOURCE INSPECTION

The contractor shall perform source inspection at the subcontractor's or supplier's facilities when directed by the procurement documentation or when one or more of the following conditions exist:

a. In-process, end-item controls, or tests that are destructive in nature prevent the contractor from verifying quality in the contractor's facility.

b. It is not feasible or economical for the contractor to determine the quality of procured articles solely by inspections or tests performed at the contractor's facility.

c. Special tests are to be performed by the subcontractor or supplier that are not economical for the contractor to repeat.

d. Products are shipped directly from the source to NASA, by-passing the contractor's inspection facilities.

7.9 CONTRACTOR RECEIVING INSPECTION

The contractor shall establish and implement a controlled, documented receiving inspection system that covers all purchased products to ensure compliance with procurement documents.

The receiving-inspection system shall consist of the following:

a. When specified by the contractor under section 7.5.3 procured products shall be accompanied by inspection and test records as evidence that the supplier is in compliance with purchase requirements and shall be accompanied by the required data directly traceable to the products. When applicable, the records shall give evidence of contractor and Government source inspection. | CH06

b. Inspections and tests shall be conducted in accordance with written procedures on selected characteristics of the products to verify their acceptability. Particular emphasis shall be placed on the selection of characteristics that have not

been contractor-source inspected and those for which nonconformances are difficult to detect during subsequent inspection and test. Test results shall be compared on a sample basis with test results provided by the supplier. Disassembly shall be performed periodically for detailed verification when required by the procurement document or the procedures.

c. The supplier's age control and limited-life product records shall be updated to reflect the receiving inspection activity.

d. Products and their records shall show acceptance or nonconformance status when released from receiving-inspection, and the products shall be protected for subsequent handling or storage. Nonconforming products shall be submitted for Material Review Board (MRB) action. Items awaiting inspection or test results or MRB action shall be segregated.

e. Receiving inspection and test records shall be maintained, including copies of documents submitted by the supplier.

g. Electrostatic discharge control procedures (par. 7.11) and the environmental control requirements (par. 7.13) shall be complied with during receiving inspection. | CH06 | CH06

7.10 CONTROL OF FABRICATION, INTEGRATION, AND OPERATIONS PHASE MAINTENANCE ACTIVITIES

The contractor shall develop and implement an Integration and Inspection Flow Plan for ECS hardware that covers activities from receipt of COTS hardware items through item level test, storage, integration, and test for acceptance in the system. For custom hardware, the plan shall show receipt and storage of parts and materials, and the flow through manufacturing, test of the items, and integration and test in the system. It shall include the inspection and test points, and Government inspection points. The plan shall be submitted in accordance with the CDRL (see Appendix C herein). The contractor shall use a documentation system (consisting of items such as work orders, fabrication orders, assembly orders, shop travelers, maintenance operation orders, and repair procedures) to control the hardware integration and

maintenance through integration and use of the ECS hardware. Controls shall ensure that only conforming hardware articles are released and used during integration and operations phase maintenance activities, and that those not involved are removed from the work area and properly stored. These documents shall include or reference (for COTS items a, e, h, and i apply as a minimum): CH06

a. Nomenclature and identification of the hardware product;

b. Tooling, jigs, fixtures, and other equipment to be used;

c. Characteristics and tolerances to be obtained;

d. Detailed procedures for controlling processes;

e. Special conditions to be maintained such as environmental conditions or precautions to be observed;

f. Workmanship standards in accordance with par. 7.10.1;

g. Controls for parts, materials, and product which have definite characteristics of quality degradation or drift with age, including requirements for recording and maintaining dates, time, or cycles for determining end of life;

h. Electrostatic discharge controls in accordance with para. 7.11; and,

i. Traceability to the individual performing each assembly, inspection, test, and maintenance task.

Contractor quality assurance shall ensure that all tasks are in compliance with up-to-date controlling documents.

7.10.1 FABRICATION AND INSPECTION REQUIREMENTS

The requirements of NHB 5300.4(3A), NHB 5300.4(3G), NHB 5300.4(3H), NHB 5300.4(3I), NHB 5300.4(3J), and NHB 5300.4(3K), shall be implemented, as appropriate in procurement, maintenance, and fabrication activities. NASA RP 1161 is recommended for the performance of printed wiring board tests and the interpretation of the test results. Samples of workmanship standards that show acceptance criteria may be used. Samples showing such acceptance criteria shall be jointly selected by the contractor and GSFC or its designated assurance representative, shall be kept current, and shall be used to train, certify, and recertify personnel. If the contractor has, and proposes to use, his existing processes, specifications and/or procedures which implement the above requirements, the contractor shall submit a comparison matrix for each of the proposed documents, noting deviations from the corresponding NASA documents cited

above, in accordance with the CDRL (see Appendix C herein).

The contractor shall develop, document, and use procedures for issuing, tracking, and closing maintenance work requests. Procedures shall also be developed to govern workmanship and inspection requirements for ECS maintenance activities (see par. 7.10).

7.10.2 TRAINING AND CERTIFICATION FOR MANUFACTURING, INTEGRATION, INSPECTION, OPERATIONS, AND MAINTENANCE PERSONNEL

a. Training - Training programs shall be developed, documented, implemented, and maintained for personnel who may have an effect upon or who are responsible for performance assurance and maintenance actions. Training shall be in accordance with applicable specifications necessary to perform the fabrication, maintenance, or inspection/test activities.

b. Certification and Recertification of Personnel - The contractor shall use trained and certified personnel for implementing the performance assurance program and maintenance activities. This shall include personnel responsible for interpretation of related accept/reject criteria, and processes control.

(1) Certification - Personnel who perform or inspect processes and operations identified in para. 7.10.1, including soldering, module welding, potting, harness fabrication, encapsulation, and nondestructive evaluations shall be trained and certified in accordance with the applicable NHB, MIL-STD, or specification. Also, the contractor shall develop and implement training and certification programs for personnel performing ECS maintenance operations and for operations personnel.

(2) Recertification - Personnel shall be annually recertified to show continuance of their ability to fabricate, maintain and/or inspect hardware. In addition, they shall be recertified if they fail to perform satisfactorily, or because of change in techniques or required skills, or by the interruption of work experience as

established for the process or operation. Recertification shall require retesting of the individual to demonstrate proficiency. Persons failing the retest shall not perform the tasks until they receive additional training and proficiency has been demonstrated. Similar recertification programs shall be developed and

implemented for maintenance personnel and for operations personnel.

c. Records - Records shall be maintained of the training, testing, certification, and recertification status of personnel. All training programs and records shall be available to the Government assurance representative in accordance with the CDRL (see Appendix C herein).

7.10.3 PROCESS EVALUATION AND CONTROL FOR CUSTOM PRODUCTS | CH06

Controls shall be implemented for processes for which high uniform quality cannot be ensured by inspection of products alone. Quality assurance shall ensure that all processes have been evaluated to ensure compliance with contract requirements. Process specifications and procedures shall be prepared for all maintenance, repair, fabrication, and manufacturing-processes used on the contract effort. Each procedure shall describe the following:

a. Preparation of the processing equipment, solutions, and materials;

b. Preparation of the product to be processed;

c. Detailed processing operations;

d. Conditions to be maintained during each phase of the process, including environmental controls;

e. Methods of verifying the adequacy of processing materials, solutions, equipment, environments, and their associated control parameters;

f. Inspection and test provisions with accept/reject criteria; and,

g. Records for documenting the results of process inspection, test, and verification.

The contractor shall provide for the certification of equipment that requires certification (e.g. welders) used in selected processes. Records of certification test results shall be maintained. Equipment shall be recertified in accordance with applicable requirements or as indicated by the results of quality audits, inspections, tests, or when

changes are made that may affect process integrity.

7.11 ELECTROSTATIC DISCHARGE CONTROL

The contractor shall develop, implement, and maintain a program to control electrostatic discharge (ESD) for any part and product susceptible to damage caused by static electricity. The program shall include provisions for work area protection, handling procedures, training, intra-plant protective covering, packaging for delivery, and quality assurance verification of conformance. Procedures shall be developed in accordance with DOD-HDBK-263 and DOD-STD-1686.

7.12 NONCONFORMANCE CONTROL

The contractor shall operate a closed-loop nonconformance control system for malfunctions and discrepancies (see Appendix B for definitions) occurring in fabrication, maintenance, test, and operations (including of orbital anomalies). The system shall include provisions for the following:

a. Documentation of each nonconformance traceable to the specific part, material, or product on which it occurred;

b. Assignment of a unique and traceable document number for each malfunction and discrepancy;

c. Description of the nonconformance and the required characteristic or design criteria;

d. Performance and documentation of analyses and examinations to determine the cause;

e. Assignment, implementation, and documentation of timely and effective remedial and preventive action on the products and applicable documents;

f. Segregation and disposition of the nonconforming product and any other products affected;

g. Signatures of authorized personnel on the appropriate nonconformance documents;

h. Accumulation and use of trend data and the performance and documentation of trend analyses from the part level to the end item product level to identify adverse trends and to provide for their

correction; and,

i. Closeout of nonconformance documentation after verifying that effective remedial and preventive actions have been taken on the nonconforming articles and any other articles potentially affected.

Nonconforming product shall be identified and, if practicable, shall be isolated for review and disposition action. Provisions for controlling nonconforming product that cannot be isolated from the normal channels of manufacturer shall be established and implemented.

The PAIP shall describe the malfunction reporting responsibilities and procedures interface between the reliability and the quality assurance organizations. The discrepancy and malfunction-control sections, as well as the software and hardware sections of the plan shall be cross-referenced.

7.12.1 CONTROL, DISPOSITION, AND REPORTING OF DISCREPANCIES

7.12.1.1 Documentation. Documentation of discrepancies shall start with the receipt of procured parts, materials, or other products, or the initiation of in-house manufacturing, whichever occurs first. Each discrepancy shall be promptly documented on the appropriate form. Documentation shall include report number, part, material or product number, lot code information, specification or procedure number, manufacturer, description of the nonconformance, disposition, and authorized approval signatures.

Documentation of discrepancies as described in the above paragraph shall also be required for maintenance operations performed to repair or replace discrepant hardware or to provide for the continued use, in as-is condition, of discrepant system hardware. However, routine maintenance operations to replace normal expired-life items or preventive maintenance operations shall be documented only in the routine maintenance documentation system (see par. 7.16).

7.12.1.2 Initial Review Disposition. Discrepant product shall be reviewed by contractor quality assurance and, as appropriate, engineering personnel and shall be subject to one of the following dispositions:

a. Return for Rework or Completion of Operations - The product shall be returned for rework using established and approved documents and operations. During and after rework, the product shall be resubmitted to normal inspection and tests.

b. Scrap - Scrap in accordance with Government-approved contractor procedures.

c. Return to Supplier - The contractor shall provide the supplier with nonconformance information and assistance, as necessary, to permit remedial and preventive action.

d. Repair in Accordance with Approved Maintenance Procedures - Malfunctions during operational use of ECS hardware that occur after acceptance of the item shall be documented as required by par. 7.12.2 and be subject to FRB review. However, the failed system shall be promptly returned to service in accordance with approved maintenance procedures. MRB action on the failed articles shall not be required.

e. Submit to Material Review Board - When the dispositions, as described above, are not appropriate, the discrepant products shall be submitted to the Material Review Board (MRB) for final disposition.

Initial review dispositions shall be recorded on non-conformance documentation.

7.12.1.3 Material Review Board (MRB). MRB action is applicable to custom designed hardware prior to its acceptance for system use and to maintenance spares that show detectable defects prior to use. It is not applicable to hardware that has malfunctioned in operational use. The MRB shall operate in accordance with the following provisions:

a. All MRB actions shall be documented on an MRB Report. An equivalent contractor form may be used provided it contains the information required by GSFC Form 4-32 (see Figure 7-1a and 7-1b) and is approved by the Contracting Officer.

b. Membership - The MRB shall comprise, as a minimum, the following members:

(1) Contractor quality representative, chairman;

(2) Contractor engineering representative;

(3) Government quality representative.

The contractor shall select members on the basis of technical competence. The Government representative on the board shall approve the membership.

c. Responsibilities - The MRB shall have the responsibility to:

(1) Determine disposition of submitted products. Any MRB decision which is not unanimous must be referred to higher authority (contractor and NASA) for resolution.

(2) Ensure that remedial and preventive actions, including reinspection and retest requirements, are recorded on the nonconformance document prior to disposition;

(3) Perform trend analysis of discrepancies.

(4) Ensure that MRB records are maintained;

(5) Ensure that the product reliability and quality are not compromised by excessive repairs.

d. Dispositions - In addition to the dispositions listed in 7.12.1.2, the MRB shall have authority for the following:

(1) Repair. The MRB shall approve repairs. Standard Repair Procedures shall be submitted to GSFC in accordance with the CDRL (see Appendix C herein). The MRB authorization shall be required for the use of the procedures for each instance of repair.

(2) Scrap.

(3) Use-As Is.

MRB disposition shall not adversely affect the safety, reliability, durability, performance, interchangeability, or other basic features of the hardware. Dispositions that, in the opinion of the MRB, will adversely affect any of the foregoing or which are contrary to any of the requirements of the contract must be submitted as a waiver request (DID 527/PA1) in accordance with the CDRL (see Appendix C herein) for Contracting Officer approval in accordance with the

project Configuration Management Plan.

Figure 7-1a. GSFC Material Review Board Report (MRB) FORM

Figure 7-1b. MRB Report Form Instructions

7.12.1.4 Supplier Material Review Board - The contractor may, with approval of NASA or its authorized assurance representative, delegate MRB responsibility to suppliers. Requests for this delegation, including a description of the overview and control the contractor will exercise over the supplier's MRB decisions, shall be submitted in accordance with the CDRL (see Appendix C herein).

7.12.2 CONTROL, REPORTING, AND DISPOSITION OF MALFUNCTIONS

The contractor shall conduct a closed-loop malfunction reporting activity for all hardware malfunctions and system-level malfunctions, whether in hardware, software, or both.

7.12.2.1 Malfunction Reporting - A malfunction (or failure) report shall be written for any departure from design, performance, testing, or handling requirement that may affect the function of the ECS hardware or compromise mission objectives. This includes test equipment that may be connected by hardwire to the ECS equipment. Other problems or anomalies that are unusual or that might affect other areas shall also be cited on a malfunction report. Reporting of ECS hardware malfunctions shall begin with the first power application at the lowest level of assembly of an electrical or electronic item or the first operation of a mechanical item. For COTS hardware, it shall begin at the first of either of the above events after delivery to the ECS contractor. Reporting shall continue throughout the life of the mission as required by the contract.

For anomalies occurring on the EOS flight hardware or software during the mission, the Spacecraft Orbital Anomaly Report (SOAR) system shall be used (see par. 7.12.3 below).

ECS software nonconformance reporting shall be in accordance with para 6.6. This provides for closed loop reporting through software development within the software development organization and for changing over to the system-level malfunction reporting system when the software is used with the ECS hardware. Changeover shall occur at the beginning of the acceptance test activity on the software involved in the malfunction.

a. Reporting Processing - A malfunction (or failure) report (MR) shall be initiated immediately after the malfunction has occurred. (See Figure 7-2a, b, and

c, for a sample report form). The contractor may use his own form for reporting if it complies with the requirements of the GSFC Malfunction Report (GSFC Form 4-2) form and is approved by the Contracting Officer. The report shall be filled out in accordance with the instructions on Figure 7-2c.

For Mrs involving the command and control functions of the FOS or those related to malfunctions that can result in inability to produce or irretrievable loss of Essential Data Products, the MR shall be given an Impact Rating as soon as practicable (see par. 7.12.2.3), to be labeled and noted on the last line of Block (17) of the form. It shall also be given a Corrective Action Effectiveness Rating as soon as the malfunction has been analyzed and the corrective action devised. This shall be labeled and noted on the last line of Block (19) of the form in accordance with the Risk Rating criteria stated in paragraph 7.12.2.3, below. The Corrective Action Effectiveness Rating shall be updated if appropriate, based on technical re-assessment prior to close-out and this final Corrective Action Effectiveness Rating labeled and noted on the sixth line of Block (20) of the form.

The reports shall be submitted to NASA in accordance with the CDRL (see Appendix C herein) and the identical information shall be given to the in-plant Government quality representative. The malfunction report data shall be submitted in hard copy and in a computer readable form which shall be as an ASCII file (with hard-copy documentation of file structures and file names). The required medium is flexible disk(s) compatible with IBM-PC DOS orMS DOS. The disks may be (1) 5.25 inch, double-sided, double-density (DS-DD), 360 kilobyte, (2) 5.25 inch high density (HD), 1.2 megabyte, (3) 3.5 inch, DS-DD, 720 kilobyte, or (4) 3.5 inch, HD, 1.4 megabyte. The hard copy update submittals shall be made as the updating actions occur on each MR, and the iteration submitted to the GSFC for closure shall include a copy of all referenced data and shall have had all corrective actions accomplished and verified.

The submittal of the data in the above specified computer readable form shall be in monthly composited updates of all currently open malfunction reports (with each data item separately identified to its respective MR). When each MR is closed, the next monthly computer composite shall carry the closure update of all Form 4-2 data on that MR.

The contractor shall maintain a master report file which contains all supplementary data such as failure analysis, reliability analysis, trend data, and records of meetings.

Figure 7-2a. GSFC Problem/Failure Report Form

Figure 7-2b. Problem/Failure Report Form Instructions

b. Status Summaries - A summary of the open malfunction reports shall be submitted as part of the Performance Assurance Status Report (par. 1.6). The summary shall list each problem or malfunction as a separate line item and provide MR number and complete identification of the affected product (part and serial numbers, or equivalent for software), the environment, date of occurrence, and a brief description of the malfunction, its cause, and the corrective action to be taken. Before removing any item from the "open" list, the last summary report shall show the corrective actions actually taken and the date closed.

7.12.2.2 Failure/Malfunction Review Board. A Failure/ Malfunction Review Board (FRB) shall be established and, as a minimum, shall comprise the following:

a. Contractor quality or reliability representative (chairman);

b. Contractor project manager or representative;

c. Contractor engineering representative who is responsible for the failed item; and,

d. Designated Government representative.

The contractor shall select members on the basis of technical competence. The Government representative on the board shall approve the membership.

The FRB shall obtain the assistance of appropriate groups and personnel, including COTS hardware suppliers, to ensure that all malfunctions are investigated, analyzed, and their causes determined. Investigations and actions shall be coordinated with NASA and documented on a malfunction report. Trend analysis shall be performed and corrective action taken. Configuration changes, if required, shall be in accordance with paragraph 7.3 and the Configuration Management Plan. Closeout of each malfunction shall require verification that remedial and preventive actions have been accomplished in the item on which the malfunction occurred, that necessary preventive design changes in the item have been accomplished and verified in test, and that effectivity of preventive actions has been established in other affected items. The FRB chairman, denoting approval of the entire Board, shall

sign the malfunction report closeout before submitting it for NASA closeout in accordance with the CDRL (see Appendix C herein). In addition, "Red Flag" reports shall be signed off as prescribed in par. 7.12.2.3. Malfunction reports shall not be considered closed until signed by the authorized Government representative.

7.12.2.3 Criticality Level CH08

The contractor shall establish a nonconformance criticality level rating system that shall have no less than three levels defined. These three minimum levels of criticality shall meet the following definitions (if more than three levels are used, the additional criticality level definitions shall define impact effects that are equivalent to or have less severity than category 3 defined below): CH08

a. Category 1: System/Service cannot perform critical function or imposes major safety hazard. CH08

Presents an immediate impact to development, operations, services, or data processing functions; imposes major safety hazard to personnel, systems, or space mission resources; or results in loss of one or more essential mission objectives. CH08

b. Category 2: System/Service substantially impaired. CH08

Substantially impacts development, operations, services, or data processing functions; fails to operate within critical performance specifications; or cannot effectively or efficiently fulfill baseline requirements. CH08

c. Category 3: System/Service slightly impaired. CH08

Causes minor or no substantial impact to development, operations, services, or data processing functions. Support may be degraded but mission can still be accomplished. CH08

Any report with an Impact Rating of "1" or "2", shall be designated a "Red Flag" report. (Malfunctions most likely to have an Impact Rating of "1" or "2" are those involving the command and control functions of the FOS or those that can result in inability to produce, or irretrievable loss of Essential Data Products.) CH08

All "Red Flag" reports require project manager sign-off (both contractor and GSFC EOS Project) for report close-out. All "Red Flag" reports shall be highlighted at the GSFC assurance reviews (see par. 2.3).

7.12.3 REPORTING OF SPACECRAFT ORBITAL ANOMALIES

For each anomaly occuring on the EOS flight hardware or software during the mission, the Spacecraft Orbital Anomaly Report (SOAR) shall be used. The NRCA system employed by the implementing contractor must provide traceability to a SOAR. CH04

Analysis, corrective action, and closure of the reported anomalies shall be accomplished under the direction of the FRB (see par. 7.12.2.2). The selection of FRB members for on-orbit anomalies shall be made so as to providing the 7-3d Soar Form appropriate skills and responsibilities. Sign-off's and distribution of copies of the SOAR report forms shall be in accordance with the SOAR instructions.

7-3a. GSFC Spacecraft Orbital Anomaly Report (SOAR) Form

7-3b. SOAR Form Instructions

7-3c. SOAR Components List

7-3d. SOAR Form Appropriate Skill and Responsibilities

7.13 ENVIRONMENTAL CONTROLS

The contractor shall establish, document and implement suitable environmental and cleanliness controls for all areas used for the operation, storage, maintenance, repair, inspection, or test of the system equipment. The contractor shall identify software storage-medium items and system hardware that are sensitive to contamination or to damage from uncontrolled environmental temperature or humidity, magnetic fields, or electrostatic discharge. The controls for these sensitive items shall be responsive to the requirements and/or recommendations of the item/equipment manufacturers and to the need for protecting the system and the software media against contamination, damage or deterioration. Temperature, humidity, and contamination standards, controls, and monitoring requirements and methods shall be stated. These control standards and procedures shall be documented, and their use shall be prescribed in an Environmental Control Plan which shall be submitted in accordance with the CDRL (see Appendix C herein).

Quality assurance personnel shall monitor the compliance of operations and activities with the Environmental Control Plan.

7.14 SPECIAL NOTICES AND ALERT INFORMATION

NASA may provide the contractor special notices (e.g. NASA TWX alerts) of general problems or selected Government-Industry Data Exchange Program (GIDEP) Alerts or SAFE-Alerts on specific parts, materials or safety problems, with inquiries as to their applicability to the ECS. The contractor shall notify NASA of any of these Alerts or problem notices which have or may have an effect on the contract hardware. In accordance with the CDRL (see Appendix C herein), the contractor shall submit responses to these Alerts and problem notices, which inform NASA of the applicability of the problem to project hardware and any follow-up action proposed. Status summaries covering each applicable Alert or notice received in a 30-day period shall be submitted as part of the Performance Assurance Status Report (1.6). The contractor shall also respond to any specific NASA inquiry on the applicability of any part or materials problem to the contract hardware.

7.15 INSPECTIONS AND TESTS

The contractor shall plan and conduct an inspection and test program which demonstrates that contract, drawing, procedure, and specification requirements are met. Inspections and tests shall be performed on products before they are installed in the next level of assembly and for repaired/replacement articles before they are placed in service on the system. Inspection and test requirements shall be applicable to all maintenance activities. Inspection shall include a review of product records. Each inspection and test shall be traceable to the individual responsible.

Quality assurance shall approve all manufacturing, maintenance, and operations activity documentation prior to its use.

7.15.1 PLANNING

The contractor shall plan for inspections and tests related to fabrication, repair, and preventive maintenance activities and for a documentation system that substantiates their accomplishment. The planning function shall provide for:

a. Orderly and timely inspection and tests at the earliest opportunity and through all phases;

b. Coordination and sequencing of inspection and tests conducted at successive levels of assembly;

c. Coordination and approval of all inspection and test procedures;

d. Availability of calibrated handling, inspection, and test equipment; and,

e. Coordination of inspections and tests conducted by the designated Government Assurance Representative.

7.15.2 INSPECTION AND IN-PROCESS TEST PROCEDURES

Inspection and in-process test activities shall be documented and conducted in accordance with approved procedures physically located at the applicable inspection or test station. The degree of detail in the procedures shall be commensurate with the complexity of inspection or in-process test operations. Inspection procedures may be a part of the manufacturing control documentation. All procedures shall

include, as applicable, the nomenclature of the article, characteristics to be inspected or tested, accept/reject criteria, equipment needed, and special consideration regarding handling, measuring, or test equipment, standards, safety, and environment.

7.15.3 INSPECTION ACTIVITY

As a minimum the following inspection tasks shall be performed at all levels of assembly:

7.15.3.1 In-Process Inspection - This task shall be performed at all levels of assembly in keeping with the following requirements:

a. The configuration, drawing requirements, and workmanship shall be verified prior to the next step of fabrication or integration; characteristics shall be verified that cannot be verified later without destructive disassembly;

b. In-process inspection shall be done in a clean environment in accordance with the Environmental Control Plan (see para. 7.13).

c. In-process inspection personnel as well as fabrication and maintenance personnel shall be certified for the selected processes and inspections; and,

d. In-process verification below the component level of assembly shall include electrical interface tests of newly fabricated or repaired assemblies prior to being integrated into the next higher level of hardware or installed in the system hardware.

7.15.3.2 Final Inspection - This task shall be performed at all levels of assembly:

a. Configuration, workmanship, and test results shall be verified before installation or use with the next higher level of assembly.

b. Quality Assurance shall verify that all non-conformances have been processed and all open items have been transcribed into the next level of inspection or fabrication documents.

c. Final inspection shall be done in a clean environment in accordance with the Environmental Control Plan (see para. 7.13).

d. Final inspection personnel shall be certified for

the selected processes and inspections.

7.15.3.3 End-Item Inspection - In addition to 'a' and 'b' above, quality assurance shall:

(1) Verify that the Acceptance Data Package (par. 7.22) is in compliance with the contract;

(2) Verify that GSFC has authorized the delivery of the end-item with such open nonconformances and unresolved tasks that may exist.

7.15.3.4 Surveillance Inspection - Stored and stocked parts, materials, and spare hardware shall be periodically inspected and tested for proper storage environment (see par. 7.13) and packaging to assess deterioration or damage. Contractor quality assurance shall identify the product and the frequency of the inspection and test.

7.15.4 QA ACTIVITIES DURING THE INTEGRATION, TEST, AND OPERATIONS PHASES

Quality assurance shall ensure that the product is integrated, tested, operated, and maintained in accordance with controlling documents. Product undergoing test shall not be adjusted, modified, repaired, reworked, or replaced except as specified in approved documents. The status, configuration, and integrity of the product must be maintained and documented.

Quality assurance shall provide surveillance of all tests, inspections, and operational and maintenance activities; the extent shall be defined in QA and test documents. As a minimum, the activities in the following list shall be performed.

7.15.4.1 Pre-Test Assurance Activity - Prior to each test, quality assurance shall verify:

a. The presence of approved inspection and test documents;

b. The identification and configuration of product;

c. That test equipment is within the calibration period for the duration of the test;

d. Test setup and test configuration is as specified in approved procedures.

e. The certification status of test and assurance personnel conforms with requirements.

7.15.4.2 Test Documentation - During each test quality assurance shall ensure:

a. That tests are conducted in accordance with approved specifications and procedures;

b. Accurate and complete recording of data and results; and,

c. The documentation of all nonconformances, rework, repairs or modifications, and in the case of malfunctions, QA shall ensure that designated personnel are contacted before proceeding (See par. 7.12.2).

7.15.4.3 Post-Test Assurance Activity - Subsequent to testing, quality assurance personnel shall:

a. Ensure proper disposition of nonconforming product; and,

b. Verify the test results, reports, and nonconformance documents are accurate, complete, and traceable to the tested product.

7.15.4.4 Software integration and test and software acceptance test - Quality assurance personnel shall verify:

a. The readiness of the software products for the test to be performed.

b. The readiness and presence of approved test software and test documents;

c. The identification and configuration of the product software;

d. That tests are conducted in accordance with the approved specifications and procedures;

e. That recording of data and results is accurate and complete; and,

f. That all nonconformances occurring during test (including procedure deviations) are properly documented for appropriate action.

7.15.4.5 Integration of Modified or New Software - For integration tests of modified or new software developed in sustaining engineering activity during the operational phase (see par. 3.3.7), quality assurance personnel shall perform the same verification activities listed in par. 7.15.4.4 and subparagraphs.

7.15.4.6 Assurance for Maintenance Activities - For each maintenance event, quality assurance shall verify that:

a. Required nonconformance documentation of the malfunction (if applicable) requiring the maintenance event has been properly initiated, correctly noted in the equipment log, and sent to the required organizations, and that designated personnel have been contacted before proceeding (See par. 7.12.2).

b. The event is conducted in accordance with the Maintenance Plan, and is conducted in accordance with a documented procedure available at the location at which the maintenance is being performed.

c. That maintenance/test equipment is within the calibration period, where appropriate.

d. Cleanliness requirements of the Environmental Control Plan (see par. 7.13) are being followed.

e. That certification status of the personnel performing the maintenance is current.

f. Required workmanship verification and electrical performance and interface tests of the spare or repaired replacement assemblies have been successfully completed and documented prior to installation in the system hardware.

g. The serial numbers or other identification of the removed and replacement assemblies are properly recorded in the configuration log.

h. That the required maintenance data for the event are accurately and completely recorded in the required documents.

i. That depot maintenance/repair sites and activities

conform with the applicable requirements of this PAR document.

7.15.4.7 Operations Phase General Activities - During the operations and maintenance phase, quality assurance personnel shall ensure that all applicable requirements of this document continue to be implemented. In particular, QA personnel shall verify that:

a. Maintenance services and operations activities are performed in conformance with applicable mission and element operations procedures;

b. Working documentation is accurate and up-to-date;

c. Discrepancy and malfunction reporting, correction, and closure activities are continued;

d. Performance trends are being detected and faults corrected in a timely manner;

e. Data products delivered to users of the system are provided in the requested format, without errors, and in a timely manner;

f. Periodic routine assessment is made of employee level of performance and training;

g. Periodic routine assessment is made of employee certification status and currentness of certification;

h. Unique mission requirements are translated into special employee training or other familiarization procedures;

i. Adequate briefing and simulation activities are conducted to prepare operations personnel for mission support.

7.15.5 RECORDS OF INSPECTIONS AND TESTS

The contractor shall prepare and maintain records, including logs, of all inspections and tests to show that all operations have been performed, the objectives met, and the end-item fully verified. The records shall be maintained and stored in a readily accessible, identifiable and retrievable

form.

Records shall cover each component, subsystem, and system. As the product is integrated, records of lower-level assembly products shall be combined into those for the end-items as a means of compiling a continuous, chronological history of identified product, fabrication, assembly, and inspection actions, and tests as well as other actions or data important to a complete assurance record, such as idle periods (storage), movement of the product, repairs, approvals, maintenance, configuration data, etc.

Quality assurance shall verify that records are complete and that the records are retained at the contractor's facility or the ECS facility for the duration of the contract in the required form and/or submitted with the Acceptance Data Package (para. 7.22).

7.16 MAINTENANCE RECORDS

During the operational phase, the contractor shall maintain operational and maintenance records as required by the ECS Maintenance Plan (DID 613/OP3). These data shall be used to support the RMA program (see par 5.5) and to provide logistics data. The maintenance records shall at least include the following data items:

a. Operating logs for each equipment. Data shall at least include on/off times, operating time, down time for each maintenance/repair event, equipment rack access records (times opened/closed, purpose, identification of individuals), and malfunction frequency data.

b. Configuration logs for each equipment. Data shall at least include a current configuration list for the equipment, dates and times of equipment or LRU installation and removal, and serial numbers of LRUs removed for repair and for the replacement LRUs.

c. A system of maintenance work orders and fabrication/ repair records covering pertinent data, including LRU identification, diagnostic data, repair operations and steps, repair time duration, hardware disposition and routing, spare parts availability (and resupply delays), test procedure for repaired item and test results.

The maintenance records shall be maintained and stored in a readily accessible, identifiable and retrievable form. The records shall be retained at the contractor's facility or the ECS facility for the duration of the contract. The maintenance records shall be available for NASA inspection at the ECS operations work sites and maintenance sites, and copies of specific documents shall be provided in accordance with the CDRL (see Appendix C herein).

7.17 CONFIGURATION VERIFICATION

Quality assurance shall verify that the as-built product complies with the as-designed configuration listing for any acceptance activity on system hardware. During all operational phases, configuration logs shall be maintained at appropriate system levels and locations that show current configuration and change records for the system area that each log covers. These logs shall show record of equipment change-outs for maintenance and indication of any configuration changes to equipment during repair operations or sustaining-engineering equipment modifications. Quality assurance shall verify on a continuing basis that the logs are up to date, that configuration changes of design (hardware or software) are CCB approved, and that obsolete drawings and documents are removed from work areas.

7.18 METROLOGY

The contractor shall establish and implement a documented metrology system that ensures measurement standards and equipment are selected and controlled to the degree necessary to meet drawing requirements. The system shall be in accordance with provisions of MIL-STD-45662. Calibration shall be maintained on all instruments, tools, gages, fixtures and equipment used in the test and inspection of product.

7.19 CONTROL SYSTEM

The contractor shall establish and maintain a documented stamp control system which provides the following:

a. Stamps, decals, tags, seals, and paints shall show that product has undergone source and receiving inspection, in-process fabrication and inspection, end-item fabrication, inspection and storage, and

shipment. Stamping methods and materials shall be compatible with the product and contract contamination requirements;

b. Stamps, decals, tags, and/or seals shall be used during the operational phase of the contract to show operational status of the equipment, use restrictions on the equipment, preventive maintenance operations performed/due, and other pertinent status information appropriate for identification on the equipment.

c. Stamps shall be applied to tags, cards, or labels attached to individual product or their containers as appropriate;

d. Stamps shall be applied to records to indicate the fabrication, maintenance, or inspection status of the products or equipment; and,

e. Stamps shall be used by fabrication, maintenance, and inspection personnel and shall be traceable to the certified individual responsible for their use. Fabrication (manufacturing) and maintenance operation stamps shall differ in design from inspection stamps.

7.20 HANDLING, STORAGE, PRESERVATION, MARKING, LABELING, PACKAGING, PACKING, AND SHIPPING

The contractor shall prepare and implement procedures for the handling, storage, preservation, marking, labeling, packaging, packing, and shipping of all products. The procedures shall implement the requirements of NHB 6000.1.

7.21 GOVERNMENT PROPERTY CONTROL

In accordance with the provisions of the contract, the contractor shall be responsible for and account for all property supplied by the Government including Government property that may be in the possession or control of a supplier. The contractor's responsibility shall include, but not be limited to, the following:

a. Upon receipt, examine product to detect damage that may have occurred in transit;

b. Inspection for quantity, completeness, proper type, size and grade as specified in the shipping documents;

c. Provision for the protection, maintenance, calibration, periodic inspection, segregation, and controls necessary to prevent damage or deterioration during handling, storage, installation, or shipment;

d. Maintenance of records which include:

(1) Identification and location of the property;

(2) Dates, types, and results of contractor inspections, tests, and other significant events;

e. The performance and documentation of functional tests or other modifications as directed by the contract.

Any property found damaged, malfunctioning, or otherwise unsuitable for use shall be processed in accordance with Government procedures and par. 7.12.

7.22 GOVERNMENT ACCEPTANCE

Prior to submittal of each release of the ECS for NASA acceptance, quality assurance shall ensure that deliverable contract hardware end-items, software, and final system documentation, including the Acceptance Data Package, are in accordance with contract requirements. QA shall also verify the closure of all nonconformances from the acceptance test program and shall participate in the Acceptance Review(s).

The Acceptance Data Package shall include the following information with appropriate approvals:

a. Records of the final system configuration audit, including the As-Built Configuration List of hardware and software (deviations from the as-designed configuration shall be noted);

b. Results of the system acceptance test program;

c. Test log books, including total operating time and cycle records;

d. List of open items with reasons for items being open and appropriate authorization/approvals;

e. Deliverable data, instruction material, and equipment for maintenance and system test;

f. Operating manuals.

The data package for the release shall be submitted to GSFC for approval in accordance with the CDRL (see Appendix C herein).

For modifications of the ECS during the operations phase that require a formal acceptance process, an acceptance package similar to that for the ECS releases shall be delivered.

APPENDIX A: APPLICABLE DOCUMENTS

SECTION NO.	DOCUMENT NO.	TITLE	AVAILABLE FROM
1.1	NHB 5300.4 (1A)	Reliability Program Requirements for Auronautical and Space System Contracts	Note 1
1.1	NHB 5300.4 (1B)	Quality Program Provisions for Auronautical and Space System Contracts	Note 1
1.1	SPAR-3	Guidelines for Standard Payload Assurance Requirements (SPAR) for GSFC Orbital Projects	Note 5
1.1 & 4.7	N/A	Functional and Performance Requirements Specification for the EOSDIS Core System	Note 5
1.1	N/A	EOSDIS Core System Phase C/D Statement of Work	Note 5
1.2	GSFC 420-05-05	EOS PAR for the IV&V of the EOSDIS	Note 5
4.7 & 6.4	NHB 2410.9	Automated Information Security Handbook	Note 2
5.3.3	MIL-HDBK-217	Military Handbook Reliability Prediction of Electronic Equipment	Note 3
5.3.3	NPRD-3 (RADC publication)	Non-Electronic Parts Reliability Data	Note 1
5.4	GSFC S-302-89-01	Failure Modes and Effects Analysis Procedure for Unmanned Spacecraft and Instruments	Note 5
5.5.2	MIL-HDBK-472	Military Standardization Handbook Maintainability Predictions	Note 3
5.6	MIL-STD-470	Military Standard Maintainability Program for Systems and Equipment	Note 3

SECTION NO.	DOCUMENT NO.	TITLE	AVAILABLE FROM
5.6	MIL-STD-471	Military Standard Maintainability Verification/Demonstration/ Evaluation	Note 3
6.3.1	N/A	NASA Information System Life-Cycle and Documentation Standards; (Software Management and Assurance Program (SMAP)	Note 5
6.5	GSFC 420-02	Earth Observing System Configuration Management Plan	Note 5 02
7.10.1	NHB 5300.4 (3A)	Requirements for Soldered Electrical Connections	Note 1
7.10.1	NHB 5300.4 (3G)	Requirements for Interconnecting Cables, Harnesses, and Wiring	Note 1
7.10.1	NHB 5300.4 (3H)	Requirements for Crimping and Wire Wrap	Note 1
7.10.1	NHB 5300.4 (3I)	Requirements for Printed Wiring Boards	Note 1
7.10.1	NHB 5300.4 (3J)	Requirements for Conformal Coating and Staking of Printed Wiring Boards and Electronic Assemblies	Note 1
7.10.1	NHB 5300.4 (3K)	Design Requirements for Rigid Printed Wiring Boards and Assemblies	Note 1
7.10.1	NASA RP-1161	Evaluation of Multilayer Printed Wiring Boards by Metallographic Techniques	Note 1
7.11	DOD-HDBK-263	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, and Equipment	Note 3

SECTION NO.	DOCUMENT NO.	TITLE	AVAILABLE FROM
7.11	DOD-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment	Note 3
7.18	MIL-STD-45662 Requirements	Calibration System	Note 3
7.20	NHB 6000.1 Handling, and	Requirements for Packaging, Transportation	Note 1

NOTES (SOURCES):

l. Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 20402.

2. NASA/Scientific and Technical Information Facility, P.O. Box 8757, Baltimore-Washington International Airport, MD, 2l240.

3. Department of the Navy, Naval Publications & Forms Center, 580l Tabor Avenue, Philadelphia, PA, l9l20.

4. National Technical Information Service, Springfield, VA. 22l6l.

5. GSFC Project Office, Code 420, Goddard Space Flight Center, Greenbelt, MD, 20771. Attention: EOS Librarian.

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APPENDIX B: ABBREVIATIONS, ACRONYMS, AND GLOSSARY

Abbreviations and Acronyms

ADP	Automated Data Processing
Ao	Operational Availability
ATRR	Acceptance Test Readiness Review
CCB	Configuration Control Board
CDOS	Customer Data and Operations System
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CIL	Critical Items List
CM	Configuration Management
CMP	Configuration Management Plan
COTS	Commercial Off-The-Shelf (hardware or software)
CRR	Capabilities and Requirements Review
DAAC	Distributed Active Archive Center
DADS	Data Archive and Distribution System
DID	Data Item Description
DOD	Department Of Defense
ECS	EOSDIS Core System
EEE	Electrical, Electronic, and Electromechanical
ELV	Expendable Launch Vehicle
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
ESD	Electrostatic Discharge
F&P	Functional and Performance (Requirements Specification)
FMEA	Failure Mode and Effects Analysis
FOS	Flight Operations Segment
FRB	Failure Review Board
FRR	Flight Readiness Review
GFE	Government Furnished Equipment
GIA	Government Inspection Agency
GIDEP	Government Industry Data Exchange Program
GSA	General Services Administration
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GSI	Government Source Inspection
IAC	Independent Assurance Contractor
I&T	Integration and Test
I&TR	Integration and Test Review
ICC	Instrument Control Center

ICF	Instrument Control Facility

Abbreviations and Acronyms (cont'd)

IV&V	Independent verification and validation
LRU	Line replaceable unit
MDT	Mean down time
MOM	Mission Operations Manager
MOR	Mission Operations Review
MR	Malfunction Report
MRB	Material Review Board
MTBF	Mean-Time-Between-Failures
MTTR	Mean-Time-To-Repair
NASA	National Aeronautics and Space Administration
NHB	NASA Handbook
ORR	Operations Readiness Review
OTS	Off-the-shelf
PAIP	Performance Assurance Implementation Plan
PAR	Performance Assurance Requirements
PAS	Platform Analysis System
PDR	Preliminary Design Review
PSC	Platform Support Center
PSR	Pre-shipment Review
PTTS	Platform Test and Training System
QA	Quality Assurance
RH	Relative Humidity
RMA	Reliability, Maintainability, Availability
RRR	Release Readiness Review
SDPS	Science Data Processing Segment
SOW	Statement Of Work
SCR	Systems Concept Review
SDR	System Design Review
SMAP	Software Management and Assurance Program
SOAR	Spacecraft Orbital Anomaly Report
SOR	System Operations Review
SPAR	Standard Payload Assurance Requirements
SRR	System Requirements Review
SSIP	System Safety Implementation Plan
STS	Space Transportation System
TBD	To Be Determined
TBS	To Be Supplied
TRR	Test Readiness Review
V&V	Verification And Validation

Glossary

Acceptance Criteria: The criteria a software product (or software-hardware system) must meet to successfully complete a test phase or meet delivery requirements.

Acceptance Tests (Ground System or Software): Formal tests conducted to determine whether a system (or discrete sub-unit of a system or software product) satisfies its acceptance criteria and to enable the customer to determine whether to accept the system.

Acceptance Tests (Hardware): The process that demonstrates that hardware is acceptable for mission use. It also serves as a quality control screen to detect deficiencies and normally to provide the basis for delivery of an item under terms of a contract.

Alert: A formal report issued by a data exchange program to its members to advise of a particular problem being experienced by one or more members that should be of general interest. The best known system is the Government Interagency Data Exchange Program (GIDEP), which issues reports in the areas of EEE parts, safety concerns, and materials.

Ancillary Data: See Data: Types of.

Architectural Design: (1) The process of defining a collection of hardware and software components and their interfaces to establish a framework for the development of a computer system to perform the functions defined in the system design requirements; or (2) The result of the architectural design process.

Architecture: See "Architectural Design". See also "Program Architecture".

Archive: A facility that provides for storing and retrieving data. There are two types of archives: active archive and permanent archive.

Auxiliary Data: See Data: Types of.

Availability: A measure of the degree to which an item is in an operable and committable state at the start of a "mission"

(a requirement to perform its function) when the "mission" is called for at an unknown (random) time. (Mathematically, operational availability is defined as the mean time between failures divided by the sum of the mean time between failures and the mean down time [before restoration of function].)

Assembly: See Hardware: Hardware Levels of Assembly.

Audit: A review of the contractor's or subcontractor's documentation or hardware to verify that it complies with project requirements.

Baseline: A configuration item identification document or set of documents formally designated and fixed at a specific time during a configuration item's life cycle and products that embody what the document(s) prescribe. Baselines plus approved changes constitute the current configuration identification.

Build: An intermediate version of a software product incorporating a specified subset of the capabilities that the final product will include.

Catastrophic Failure: A failure whose potential effect would result in loss of a primary mission objective or result in fatality or serious injury to personnel or serious damage to the launch facility or vehicle. e.g., loss of ability to recover primary-objective science data would be catastrophic to an instrument mission.

Component: See Hardware: Hardware Levels of Assembly. See also ECS: Levels of Assembly.

Configuration: (1) The functional and/or physical characteristics of a software or hardware item as set forth in technical documentation and achieved in a product. (2) The functional and physical characteristics of parts, assemblies, equipment of systems, or any combination of these which are capable of fulfilling the fit, form and functional requirements defined by performance specifications and engineering drawings.

Configuration Control: The systematic evaluation, coordination, and formal approval/disapproval of proposed changes and the implementation of all approved changes to the design and production of an item, the configuration of which has been formally approved by the contractor or by the

purchaser, or both.

Configuration Management: The systematic control and evaluation of all changes to baseline documentation and subsequent changes to that documentation which define the original scope of effort to be accomplished (contract and reference documentation) and the systematic control, identification, status accounting and verification of all configuration items.

COTS hardware: See Hardware.

COTS Software: Software sold commercially to a variety of users to be used unmodified to perform specified functions in a specified environment(s). It is controlled and maintained by the developer.

Critical Failure: A failure whose potential effect would result in a significant (as determined by the Project) performance degradation of an item of hardware or a mission. Specifically, a "Criticality 3" (or 2 or 1) failure, as defined in par. 5.3.4 of this document.

Critical Items List (CIL): A list of potential single failures, as determined by Failure Mode and Effects Analysis (FMEA), that would be catastrophic (Criticality 1 or 2) or critical (Criticality 3) if they occurred during the mission. The CIL also lists EEE parts that are applied in violation of the derating criteria.

Critical Software Item: Software systems/subsystems that have a critical command, control, or data receiving/storing function, such that there is the risk of a malfunction resulting in damage to or loss of the flight hardware or the mission, including inability to produce or irretrievable loss of Essential Data Products.

Data Processing Level:

Level 0: Raw instrument data at original resolution, time ordered, with duplicities removed.

Level 1A: Level 0 data, which may have been reformatted or transformed reversibly, located to a coordinate system, and packaged with needed ancillary, engineering, and auxiliary data.

Level 1B: Irreversibly transformed values of the instrument measurements(e.g., radiances, marine

conductivity). For in-situ observations, the level 1b product is also the geophysical parameter of interest

(e.g., particle flux, ambient magnetic field vector, radiosonde generated atmospheric temperatures).

Level 2: (1) Geophysical parameters located in space and time. (2) Corrected level 1b geophysical parameters for in-situ measurements.

Level 3: Geophysical parameters resampled onto space-time grids.

Level 4 and higher: Uniquely defined for each mission.

Data Product: The output of data processing. e.g., a level 1b data product is the output of level 1b data processing.

Data: Types of:

Ancillary Data: Data other than instrument data required to perform an instrument's data processing. They include orbit data, attitude data, time information, spacecraft or platform housekeeping data (e.g. pointing or alignment information, optics temperature, structure temperature), calibration data, data quality information, and data from other instruments (supplemental information).

Auxiliary Data: Data other than ancillary data and instrument data needed for processing the science data produced by the instrument.

Essential Data Products: Science data products identified in program-level documentation (e.g., the EOS Program Level Technical Requirements (PLTR), vol. 4) as mission success criteria for specific EOS instruments and science investigations.

Instrument Engineering Data: Data produced by engineering sensors of an instrument, used for processing the science data generated by the instrument.

Instrument Science Data: Data produced by the science sensors of an instrument, usually constituting the basic reason for existence of the instrument.

Design Requirements: The formally stated specification of the performance, functional, operational, and physical requirements that a software-hardware system or component

thereof (at any level) must meet in order to be acceptable for its intended use; the first iteration of design

definition. (Often referred to simply as "the requirements" or Level (n) Requirements).

Design Specification: Generic designation for a documented specification which describes functional and physical requirements for a software or hardware item. For hardware, design specifications are usually for components or for items at higher levels of assembly. In its initial form, the design specification is a statement of functional requirements with only general coverage of physical and test requirements. The design specification evolves through the project life cycle to reflect progressive refinements in performance, design, configuration, and test requirements. In many projects the end-item specifications serve all the purposes of design specifications for the contract end items. Design specifications provide the basis for technical and engineering management control.

Designated Representative: An individual (such as a NASA plant representative), firm (such as assessment contractor), Department of Defense (DOD) plant representative, or other Government representative designated and authorized by NASA to perform a specific function for NASA. As related to the contractor's effort, this may include evaluation, assessment, design review participation, and review/approval of certain documents or actions.

Deviation: A specific written authorization granted prior to the manufacture of an item to depart from a particular or design requirement of a specification,drawing or other document for a specific number of units or a specific period of time.

Discrepancy: See Nonconformance.

Distributed Active Archive Center (DAAC): An ECS-unique hardware and software system residing at institutional facilities. Each DAAC will include a Product Generation System (PGS), a Data Archive and Distribution System (DADS), and an element of the Information Management System (IMS). The DAACs will process data from the EOS instruments to standard level 1-4 data products, provide short- and long-term storage for EOS data and selected non-EOS data, and distribute the data to ECS users.

ECS: Levels of Assembly:

Unit: A level of software assembly capable of being designed and coded by a single programmer. It may be one or more functionally interdependent modules or one or more interdependent subroutines. (The lowest level of software assembly controlled as a separate entity under the performance assurance requirements of this PAR document.)

Component: The lowest level subdivision identification of the ECS. It comprises software and interdependent dedicated hardware. The term may also be used to denote only the software portion.

Subsystem: The next subdivision of an ECS element. It comprises software and interdependent dedicated hardware necessary to perform an identified sub-function of the element. The term may also be used to denote only the software portion.

Element: A major functional subdivision of an ECS segment (e.g., the EOC is an element of the FOS; a DAAC is an element of the SDPS). Elements are further subdivided into subsystems and components.

Segment: One of the three functional subdivisions of the ECS. They are the Flight Operations Segment (FOS), the Science Data Processing Segment (SDPS), and the Communications and System Management Segment (CSMS).

System: The ECS.

Effectivity: The point (in configuration evolution) at which a change or action becomes applicable to the hardware or software.

Electromagnetic Compatibility: The condition that prevails when various electronic devices are performing their functions according to design in a common electromagnetic environment.

Electromagnetic Interference (EMI): Electromagnetic energy which interrupts, obstructs, or otherwise degrades or limits the effective performance of electrical equipment.

Electromagnetic Susceptibility: Undesired response by a component, subsystem, or system to conducted or radiated electromagnetic emissions.

Element: See ECS: Levels of Assembly.

EOSDIS Core System (ECS): That portion of the EOSDIS covered by the GS&O Project managed Phase C/D development, maintenance, and operations contract. This covers the bulk of the EOSDIS, but excludes the components that are funded independently (to science investigators).

EOS Data and Information System (EOSDIS): The ground based system for command and control of U.S. EOS observatories and instruments and for providing the earth sciences community with data obtained by earth observing instruments for use under the EOS program. It will produce a variety of standard data products, maintain information about the data and products, provide data archiving and distribution capabilities, and provide a user interface which will facilitate browsing, requests for data, and transfer of data from archives to investigators.

End-to-End Tests: Tests performed on the integrated ground and flight system, including all elements of the payload, its control, communications, and data processing to demonstrate that the entire system is operating in a manner to fulfill all mission requirements and objectives.

EOS Operations Center (EOC): An element of the ECS flight operations segment responsible for command and control, operations planning and scheduling, and health and safety monitoring of the EOS observatory

Essential Data Products: See Data: Types of.

Failure: See Nonconformance.

Failure Modes and Effects Analysis (FMEA): Study of a system and working interrelationships of its elements to determine ways in which failures can occur (failure modes), effects of each potential failure on the system element in which it occurs and on other system elements, and the probable overall consequences of each failure mode on the success of the system's mission. Criticalities are usually assigned by categories, each category being defined in terms of a specified degree of loss of mission objectives or degradation of crew safety.

Functional Tests: The operation of a unit in accordance with

a defined operational procedure to determine whether performance is within the specified requirements.

Ground Systems and Operations (GS&O): The formal name for GSFC Code 423 Project organization, which is responsible for all EOS command, data and information systems and the on-orbit operations of the EOS observatories.

Hardware: Physical items of equipment. As used in this document, there are two major categories of ECS hardware as follows:

1. COTS Hardware: Commercial, off-the-shelf computer hardware, including peripheral units, designed and specified by the manufacturer, and intended to be used without modification by the customer.

2. Custom Designed Hardware: ECS hardware items or portions thereof which are wholly or partially designed specifically for the ECS (includes modified COTS items). Such hardware is subject to appropriate development program controls including hardware assurance measures.

3. Hardware Levels of Assembly

Part: A hardware element that is not normally subject to further subdivision or disassembly without destruction of designed use.

Subassembly: A Subdivision of an assembly. Examples are wire harness and loaded printed circuit boards.

Assembly: A functional subdivision of a hardware component, consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole. Examples are a power supply, memory unit, disk head assembly.

Component: A functional subdivision of a hardware subsystem. It is generally a self-contained combination of hardware items performing a function necessary for the subsystem's operation. Examples are a disk drive, central processing unit (CPU), work station, printer, tape drive.

Platform: The integrated assemblage of equipments which provides all housekeeping resources and services necessary to support the operations of the EOS payload set, including mechanical support and alignment; attitude control; orbit determination and guidance; electrical power; temperature control and excess heat rejection; data communications; data formatting, storage, and routing; and measurement of the local contaminant environment.

Observatory: The complete flight segment of a space system consisting of the spacecraft bus (EOS platform, for EOS), mission unique flight equipment, and instrument payload. For the EOS Platform contract, "Observatory" is defined as "A fully-integrated spacecraft comprising a platform and its payload set."

Payload: An integrated assemblage of subsystems designed to perform a specified mission in space. Examples: an EOS flight instrument may be a payload on the EOS Observatory; the EOS Observatory is a payload on the Titan IV launch vehicle.

Inspection: The process of measuring, examining, gaging, or otherwise comparing an article or service with specified requirements.

Instrument: A subsystem consisting of sensors and associated hardware for making measurements or observations in space. The flying portion of a flight experiment.

Instrument Engineering Data: See Data: Types of.

Instrument Control Center (ICC): An element of the ECS flight operations segment responsible for scheduling, commanding, operating, and monitoring the health and safety of a science instrument in the payload of the EOS observatory.

Instrument Science Data: See Data: Types of.

Integration: The process of combining lower level software items to form higher level items.

Integration Testing: The process of combining and testing at successive levels of assembly as build-up of a system occurs.

Key Parameter Software: The software necessary to process from raw down-linked (Level 0 processed) instrument science data, instrument engineering data, and ancillary data to the form of output data product the Project is committed to furnish to users. For one project the software may be that necessary to produce a level 1 data product, and for another it might be software to process to a level 2 or higher product. For the ECS, key parameter software will generate Level 1, 2, 3, and 4 products.

Level of repair: Level of hardware assembly at which repairs will be made in a certain environment. e.g., part level, circuit board level, component ("box") level.

Level of maintenance: Organizational level at which a given maintenance operation will be performed. e.g., the line or field level, the depot level, the factory level.

Maintainability: The measure, expressed as a probability, of the ability of an item to be retained in or restored to specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair.

Margin: The amount by which hardware capability exceeds requirements.

Model. Generic term to describe a physical or mathematical simulation of an article of hardware, software, or part or all of a mission system. To be useful for purposes of this document, the term must be further identified as to the nature of the model and its purpose. Two examples are:

1. Thermal Model. Unless identified to the contrary by context, this term describes a hardware model. A Thermal Model is a unit of hardware thermally equivalent to a Flight Unit, but need not be capable of the optical, electrical functions or structural/ mechanical survivability of a Flight Unit.

2. Thermal Math Model. This may also be called an "analytical thermal model" and is defined as an analytical model used to evaluate the thermal performance of an article of the flight hardware, such as the flight instrument. A reduced node version of this model is used to evaluate the instrument-spacecraft combination. These models shall be refined after comparison with thermal test data.

Monitor: To keep track of the status or progress of an activity or function (e.g., operation of an instrument, conduct of a test). With regard to a performance assurance activity, the monitor need not be present at the scene during the entire course of the activity, but he/she will review resulting data or other associated documentation (see Witness).

Nonconformance: A condition of any hardware, software, material, or service in which one or more characteristics do not conform to requirements. As applied in quality

assurance, nonconformances fall into two categories--discrepancies and malfunctions (including failures). A discrepancy is a departure from specification that is detected during inspection or process control testing, etc., while the hardware or software is not functioning or operating. A malfunction is a departure from specification that is discovered in the functioning or operation of the hardware or software.

Observatory: See Hardware: Hardware Levels of Assembly.

Part: See Hardware: Hardware Levels of Assembly.

Payload: See Hardware: Hardware Levels of Assembly.

Performance Verification: Determination by test, analysis, or a combination of the two that the payload or system element can operate as intended in or to support a particular mission; this includes being satisfied that the design of the payload or element has been qualified and that the particular item has been accepted as true to the design and ready for operational use.

Platform Analysis System (PAS): A system, located within the EOSDIS and associated with the EOC, which provides capability for analysis of EOS platform status and subsystem performance.

Platform Test and Training System (PTTS): A system located within the EOSDIS, and associated with the EOC capable of simulating the operation of the EOS-A command and data handling (C&DH) subsystem. It purpose is to support ground system test, to train EOC operators, to test operational procedures, and to assist in analysis of on-orbit platform performance anomalies.

Previously Developed Software: Software developed and used on other programs which may be utilized to perform functions required by the ECS. Its design may be modified and controlled by the EOS GS&O Project. This term is also used in this document to cover software obtained from commercial sources writing and selling software that the user is encouraged to modify to meet user requirements. Previously Developed Software requires establishment of its suitability for use on ECS and the application of the assurance requirements of this document to any modifications of it.

Product: Generic term used to denote the output of any process. When unmodified, the term is used here to mean any software or hardware item (an input item of one process is usually an output item of a previous process.).

Program Architecture: The structure and the relationship among the components of a software program. The program architecture may also include the program's interface with its operational environment.

Redundancy (of design): The use of more than one independent means of accomplishing a given function.

Repair: The article is to be modified by established (customer approved where required) standard repairs or specific repair instructions which are designed to make the article suitable for use, but which will result in a departure from the original specification.

Rework: Return for completion of operations (complete to drawing). The article is to be reprocessed to conform to the original specifications or drawings.

Segment: See ECS: Levels of Assembly.

Single Point Failure: A single element of hardware the failure of which would result in loss of mission objectives or the hardware, as defined for the specific application or project for which a single point failure analysis is performed.

SMAP-DID: A single data item description document (standard) from the guideline publication set entitled, "Information System Life-Cycle and Documentation Standards", published under the Software Management Assurance Program, NASA headquarters.

Spacecraft: See Hardware: Hardware Levels of Assembly.

Subassembly: See Hardware: Hardware Levels of Assembly.

Subsystem: See Hardware: Hardware Levels of Assembly.

Unit: See ECS: Levels of Assembly.

Verification: See Performance Verification.

Waiver: A written authorization to accept a configuration item or other designated item(s), which during production or after being submitted for inspection, are found to depart from specified requirements, but nevertheless are considered suitable for use "as is" or after rework by an approved

method.

Witness: A personal, on-the-scene observation of a performance assurance activity with the purpose of verifying compliance with project requirements. (see Monitor).

APPENDIX C

PERFORMANCE ASSURANCE DATA REQUIREMENTS LIST FOR THE ECS

The listing of contractor deliverable documents, below, is incorporated in the ECS contract DRL. It is provided here for reference to show the total of each requirement in this PAR document.

DID NO.	REF. PARA.	DESCRIPTION	NASA ACTION*	
501/PA1	1.3 4.2	Performance Assurance Implementation Plan (PAIP)	I	
502/PA3	1.3 & 1.3.2 4.2	Contractor's practices and procedures referenced in the PAIP	R/A	CH07
504/PA1	1.4	Previously designed or off-the-shelf hardware and software data:		CH02
		a.Preliminary	R	
		b.Updates	A	
503/PA3	1.6	Performance Assurance Status Report	I	
506/PA3	1.9.2	Audit reports	I	
	2.2	Data for GSFC Assurance Reviews:		
	2.2.a	Copies of material to be presented at GSFC Assurance reviews	I	
	2.2.a	Copies of material to be presented at Project reviews	I	

DID NO.	REF. PARA.	DESCRIPTION	NASA ACTION*	
508/PA1	2.2.c	Responses to recommendations and action items	A	
	2.5	Notification of contractor reviews	I	
401/VE1	3.1.1	Verification Plan for each Release (including software test plans & test matrix):		
		a.Preliminary	I	
		b.Final	A	
		c.Updates (of Plan)	A	CH02
		d.Updates (of Portions, e.g., software test plans)	A	
407/VE3	3.1.1	Matrix of Tests Accomplished:		
		a.Initial	I	
		b.Updates	I	
424/VE2	3.1.2	Verification procedures	R	
404/VE1	3.1.3	Procedure for control of unscheduled activities during verification	A	
406/VE3	3.1.4	Verification reports (and software test reports)	I	

DID NO.	REF. PARA.	DESCRIPTION	NASA ACTION*	
513/PA2	4.3.	Hazard analyses for each Release:		
		a.Preliminary	R	
		b.Final	R	
		c.Updates	R	
514/PA2	4.7	Security-Sensitive Items List for each Release:		
		a.Preliminary	R	
		b.Final	R	CH02
		c.Updates	R	
515/PA3	5.3.1	Availability Models:		
		a.Preliminary	I	
		b.Final	I	
		c.Updates	I	
516/PA2	5.3.3	Reliability Predictions:		
		a.Preliminary	I	
		b.Final	I	
		c.Updates	I	
517/PA2	5.3.4	Failure Modes & Effects Analyses and CIL:		
		a.Preliminary	R	
		b.Final	R	
		c.Updates	R	

DID NO.	REF. PARA.	DESCRIPTION	NASA ACTION*	
518/PA3	5.5.2	Maintainability Predictions:		
		a.Preliminary	I	
		b.Final	I	
		c.Updates	I	
511/PA2	5.6	Maintainability Demonstration Plan:		
		a.Initial	R	CH02
		b.Update	R	
512/PA2	5.6	Maintainability Demonstration Test Plan	R	
519/PA3	5.6	Maintainability Demostration Test Reports	I	
520/PA2	6.4	Software Critical Items Lists:		
		a.Initial	R	
		b.Update	R	
		c.Update	R	

DID NO.	REF. PARA.	DESCRIPTION	NASA ACTION*
521/PA3	6.6	Software Nonconformance Reports (formal):	
		a.Notification	I
		b.Written notification (hard copy & computer days readable data of form)	I
		c.Failure analysis, proposed corrective action	I
		d.Computer-readable data of form (for current update of the respective reports)	I
522/PA2	7.10	Integration & Inspection Flow Plan:	
		a.Preliminary	R
		b.Final	R
523/PA1	7.10.1	Contractor workmanship standards or procedures proposed instead of NHB's	A
525/PA3	7.10.2.c	Training and certification records	I
526/PA1	7.12.1.3.d(1)	Standard repair procedures	A
527/PA1	7.12.1.3	Request for Waiver or Deviation	A
528/PA1	7.12.1.4	Request for delegation of MRB authority to a supplier	A

DID NO.	REF. PARA.	DESCRIPTION	NASA ACTION*
529/PA3	7.12.2.1	Malfunction/Failure Reporting:	
		a.Notification	I
		b.Written notification (hard copy & computer-readable data of MR form)	I
		c.Failure analysis, proposed corrective action	I
		d.Computer-readable data of MR form (for current update of the respective MR's)	I
530/PA1	7.12.2.2	Malfunction/failure report close-out	A
531/PA3	7.12.3	SOAR Reports:	
		a.Notification	I
		b.Written notification (hard copy of SOAR form)	I
532/PA2	7.13	Environmental Control Plan:	
		a.Initial	R
		b.Updates	R
533/PA2	7.14	Response to Problem Notices & Alerts	R
534/PA3	7.16	Maintenance records:	
		a.All records	I

		b.Specific documents	I

DID NO.	REF. PARA.	DESCRIPTION	NASA ACTION*
535/PA1	7.21	Acceptance Data Package for each Release and End Item, comprising: a.As-Built Configuration List of hardware and software b.Test logs and records including total operating time and cycle records c.List of open items with reasons for items being open (and authorizations) d.Deliverable data, instruction material, and equipment for maintenance and system test; e.Operating manuals.	A

*A - NASA approves. The developer may proceed only after receiving written approval of the Contracting Officer.

R - NASA reviews and may comment within 30 days; developer may continue work unless comment requires him to stop.

I - Information; the developer's work schedule is not normally affected.

GSFC 420-05-03
May 23, 1991

EARTH OBSERVING SYSTEM (EOS)

PERFORMANCE ASSURANCE REQUIREMENTS

FOR

THE EOSDIS CORE SYSTEM (ECS)

Goddard Space Flight Center
Greenbelt, Maryland

EARTH OBSERVING SYSTEM (EOS) PROGRAM

PERFORMANCE ASSURANCE REQUIREMENTS

FOR

THE EOSDIS CORE SYSTEM (ECS)

Approved by:

_____ _____

George R. Stonesifer
EOS Ground System and Operations
System Assurance Manager

_____ _____

Donald G. Anna
EOS Flight Assurance Manager

_____ _____

Thomas D. Taylor
EOS Ground System and Operations
Project Manager

This is a Project Office Controlled Document. Changes require prior approval of the Project Manager. Proposed changes shall be submitted to the EOS Ground System and Operations Project Configuration Management Officer (Code 423).

_____

Thomas D. Taylor date
EOS Ground System and Operations
Project Manager

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FIGURES

FILE LABEL 5/22/91 DIS-PAR1.SIG